June 2003

Programmatic Environmental Assessment for Ballast Water Management Program for U.S. Waters

PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

FOR

MANDATORY BALLAST WATER MANAGEMENT PROGRAM FOR U.S. WATERS

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1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

1.1 Purpose and Need for the Proposed Action

A major pathway for the introduction of nonindigenous species (NIS) is ballast water discharge from vessels entering U.S. waters after operating outside of the Exclusive Economic Zone (EEZ). NIS are organisms found outside of its native or historical range. In cases where they invade ecosystems, NIS can alter aquatic and marine ecosystems and biodiversity, impact commercial and recreational fisheries, cause infrastructure damage, increase potential risks to human health, and generally cause detrimental economic impacts.

Vessels carry ballast water when not fully loaded with cargo in order to lower the vessel in the water, increasing stability and vessel safety. In port, vessels take on ballast water in order to increase vessel draft and to allow the vessel to fit under bridges or cranes. Also, vessels commonly deballast and reballast during cargo loading and unloading in order to maintain stability (National Research Council 1996).

While introductions of NIS into U.S. waters have been ongoing for over 400 years, they became a legislative focus in the 1980s with the introduction of the zebra mussel (*Dreissena polymorpha*) to the Great Lakes, most likely via ballast water discharge. The rapidly reproducing zebra mussel first attracted attention by clogging domestic water supply and electric generating facility intake pipes, causing costly infrastructure damage and control commitments. The zebra mussel has since spread extensively throughout the Great Lakes and the Mississippi River watershed, and continues to cause considerable ecological and economic harm.

Congress responded to the concerns of NIS through the enactment of the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990. NANPCA established a program for preventing, researching, monitoring and controlling the introduction of NIS via ballast water discharge. Under NANPCA, the U.S. Coast Guard was given authority to issue Ballast Water Management (BWM) regulations, including ballast water exchange, for vessels entering the Great Lakes and Hudson River, to reduce the introduction of NIS. In response to NANPCA's directive, a Final Rule (33 CFR part 151, subpart C) mandating BWM requirements for the Great Lakes (58 FR 18330, April 8, 1993) was implemented. The provisions were later extended to include the Hudson River, north of the George Washington Bridge (59 FR 67632, December 30, 1994).

NANPCA was reauthorized and amended by the National Invasive Species Act (NISA) of 1996 and directed the U.S. Coast Guard to issue BWM regulations applicable to all U.S. waters. Under NISA, the U.S. Coast Guard issued voluntary BWM guidelines for all vessels entering U.S. waters after operating outside of the EEZ (66 FR 58381, November 21, 2001). These regulations also finalized mandatory BWM requirements for vessels entering the Great Lakes and Hudson River, after operating outside of the EEZ. Additionally, these regulations require that all vessels maintain accurate records of volumes and sources of ballast water and report ballast water exchange activities to the U.S. Coast Guard. These regulations do not identify penalties for non-compliance with any voluntary or mandatory BWM requirements.

Under NISA, Congress instructed the Secretary of Transportation (Secretary) to submit a Report to Congress evaluating the effectiveness of the voluntary BWM guidelines. If, on the basis of a periodic review, the Secretary determined that either (a) the rate of effective compliance with the guidelines was inadequate; or (b) the reporting by vessels pursuant to those guidelines was not adequate for the Secretary to assess the compliance with those guidelines and provide a rate of compliance of vessels, the Secretary shall promptly promulgate regulations that make voluntary guidelines mandatory. The Secretary's Report to Congress, signed June 3, 2002, concluded that compliance with the voluntary guidelines (33 CFR part 151, subpart D) was insufficient to allow for an accurate assessment of the voluntary BWM guidelines.

Recognizing that the current regulatory scheme of voluntary BWM is less than 100 percent effective in achieving its goal, the Secretary's Report to Congress recommended that the highest possible rate of compliance should be sought since anything less than 100 percent compliance would facilitate the continued release of NIS to U.S. water (USCG 2001). Accordingly, the Secretary stated his intention to make the voluntary BWM guidelines mandatory. Therefore, the U.S. Coast Guard proposes a rulemaking to make the voluntary BWM guidelines mandatory for all vessels with ballast water tanks that enter waters of the U.S. after operating outside of the EEZ. For the purposes of this rulemaking, U.S. waters include the waters of all 50 States, the District of Columbia, Puerto Rico, Guam, American Samoa, the U.S. Virgin Islands, and the Trust Territories of the Pacific Islands. The proposed rulemaking is anticipated to increase the number of vessels conducting mandatory BWM prior to entering U.S. waters, and therefore should better control the introduction of NIS through ballast water discharge.

1.1.1 Understanding the Need for Mandatory Ballast Water Management

The rate of NIS introductions to U.S. waters is increasing (Ruiz *et al.* 2000a, Carlton *et al.* 1995). NIS introductions have been cited as the second greatest threat to biodiversity behind habitat loss (Vitousek *et al.* 1997) and are considered one of the most important issues facing the maritime community (USCG 2001). A major vector for the introduction of NIS is through ballast water discharge (Carlton 2001, Ruiz *et al.* 2001, Ruiz *et al.* 2000a, Barrett-O'Leary 1999, 33 CFR 1998, National Research Council 1996, Carlton and Geller 1993). In fact, vessels involved in international commerce are referred to as "biological islands" with their ballast water acting as worldwide conveyor belts for biota (Carlton 2001, National Research Council 1996, Carlton *et al.* 1995).

NIS have been transported to and from U.S. waters and around the globe via ballast water discharge for decades. However, this does not imply that all potential species introductions have already occurred. As shipping routes change and shipping technologies advance, the opportunities for NIS introductions also change. The size, speed, and travel distance of modern vessels has contributed exponentially to the increase in NIS introductions (Ruiz *et al.* 2000a).

New trade routes can develop as new commodities become available or as political and economic conditions open up ports to international commerce (Carlton 1996b, Carlton *et al.* 1995). As water from these new regions is used as vessel ballast, a new suite of NIS may be imported and discharged to U.S. waters. Even along established routes, changes in the environmental characteristics or organism populations of donor or recipient regions may provide new opportunities for NIS introductions (Carlton 1996b, Carlton *et al.* 1995).

Shipping routes function as spokes of a hub allowing ballast water transported along these routes to have multiple and varied sources (Carlton 1999b, Carlton 1996b, National Research Council 1996). For instance, once a NIS is introduced and survives in an area, that area then becomes a potential donor region. It is not realistic to prevent NIS introductions by simply restricting import from particular regions.

The shipping industry has clear economic incentives to decrease voyage times, and new technologies have focused on creating faster vessels. As transport time decreases, the survival rate and health of biota in ballast water tanks increases, leading to a greater potential for the introduction of viable NIS (Drake *et al.* 2002, Carlton *et al.* 1995). Increased speed may also allow a vessel to visit more ports in a shorter amount of time, increasing the number and rate of potentially impacted areas. These factors contribute to an increased potential for the distribution of viable NIS to U.S. waters via ballast water.

Ballast serves an essential role in safe, efficient, and successful operation of vessels. The uptake or discharge of ballast water may be conducted for a variety of reasons including controlling the trim, draft, and stability of a vessel. Ballast water functions as a surrogate load in place of cargo, fuel, usable water, and personnel. Modern cargo vessels can carry enormous volumes of ballast water (i.e., tens of millions of gallons), any portion of which may be discharged for various reasons along any part of a journey (Carlton *et al.* 1995). The increased size and ballast water capacity of modern vessels has increased the number of individual organisms transported and released around the world. In U.S. waters, the total amount of ballast water discharge is greater than 21 billion gallons per year, or more than 2 million gallons per hour (Carlton *et al.* 1995).

As ballast water is taken aboard a vessel, any organisms associated with the ballast water will be entrained in the ballast tanks. Virtually all aquatic species from microscopic viruses and bacteria to zooplankton, fish and plants can be entrained and transported in ballast water (Hines and Ruiz 2000). This can include organisms that reside in the sediments, water column, water surface, or any combination. Organisms may be entrained during adult, juvenile, or larval stages. In addition, all symbionts, parasites, and pathogens associated with an organism will also be entrained (National Research Council 1996, Carlton *et al.* 1995). It is estimated that globally more than 10,000 different species may be transported in ballast water on any given day (Carlton 1999b).

The complexity of species transport, introduction, and survival make it extremely difficult to predict where and when bioinvasions may occur (Carlton 1996b, National Research Council 1996, Carlton *et al.* 1995, Carlton 1992). When a species is discharged into a new environment it does not necessarily mean that the species will become established (i.e., become a successfully reproducing population). A complex series of biological and environmental factors influence the establishment of NIS. First an organism must be taken up and survive the rigors of the ballasting process. The organism must then survive the transport to a new area: in general, the longer the voyage, the lower the potential for survival. The organism must then survive release into the new environment. When organisms are discharged with ballast water they encounter new physical and chemical conditions without time to acclimate. Survival in the new environment can depend on short-term tolerances to the new physical environment as well as the overall compatibility of the environmental conditions of the receiving and donor waters (Hines and Ruiz 2000); initial survival of an individual does not constitute establishment. As a result, survival rates of introduced NIS are typically low (Mack *et al.* 2000). Establishment is only achieved if a species is able to successfully survive and reproduce over several generations within the new ecosystem (Wonham *et al.* 1996). However, with large volumes of ballast water containing high concentrations of NIS, even a low rate of survival can pose a bioinvasion threat.

1.2 Proposed Action

The Proposed Action would revise 33 CFR parts 151 as required by NISA. Specifically, subpart D of 33 CFR 151 would be revised to require mandatory BWM for all vessels equipped with ballast water tanks entering U.S. waters after operating outside of the EEZ. Existing mandatory BWM requirements for vessels entering into the Great Lakes and Hudson River would remain unchanged. This mandatory BWM program would require all vessels to conduct one of the following BWM practices:

1. *Exchange ballast water beyond the EEZ, in an area more than 200 nautical miles from any shore.* This refers to conducting mid-ocean ballast water exchange, exchanging ballast water obtained

from ports or coastal waters outside of the EEZ with mid-ocean waters, prior to ballast water discharge in U.S. waters.

A. *Empty and refill exchange*. Ballast water taken on in ports or coastal waters outside of the EEZ are discharged until the ballast tank is empty (as close to 100 percent empty as vessel navigation and safety considerations will allow). The tank is then refilled with mid-ocean water.

B. Flow through exchange. Ballast water taken on in ports or coastal waters outside the EEZ is flushed out of the ballast water tanks by pumping in mid-ocean water at the bottom of the tank and continuously overflowing the tank from the top. This flushing continues until three full ballast water tank volumes have been pumped.

2. *Retain ballast onboard the vessel.* A vessel that does not choose to conduct mid-ocean exchange may elect to retain its ballast water onboard while in U.S. waters.

3. Use an "environmentally sound" U.S. Coast Guard-approved alternative ballast water management method before the vessel enters the U.S. EEZ. An alternative environmentally sound method of BWM is a method, effort, action, or program that will prevent and control NIS introductions during ballast water discharge. U.S. Coast Guard is in the process of developing a program for approving this type of ballast water management. This will be addressed in future rulemakings.

4. Discharge ballast water to an approved reception facility. An approved reception facility is a shoreside ballast water holding or treatment facility that is specifically used to accommodate ballast water discharge from vessels.

To meet the mandatory BWM requirements of the Proposed Action, no vessel would be required to deviate from its voyage, or delay its voyage, to conduct a ballast water exchange. A vessel that cannot meet the ballast water management requirements because its route does not enter waters 200 nautical miles or greater from any shore and/or because of safety concerns, would not be prohibited from discharging ballast water in U.S. waters, with the exception of the Great Lakes and the Hudson River. However, in this case, the vessel must discharge only an amount of ballast water that is operationally necessary, and, upon request, must provide documentation to the local Captain of the Port (COTP) supporting its claim that it could not comply with the mandatory BWM requirements.

The Proposed Action would require that all vessels comply with the mandatory BWM program, thereby increasing the U.S. Coast Guard's ability to protect U.S. waters from the introduction of NIS, and be in compliance with the NISA.

1.3 Limitations of the Proposed Action

The Proposed Action is directed exclusively at the mandatory management of ballast water from outside the U.S. EEZ, and is intended as a mechanism to reduce NIS introductions to U.S. waters. While ballast water from outside the EEZ is a major vector for aquatic NIS introductions, other vectors do exist.

The transfer of ballast water between domestic sources is also an important issue and results in the discharge of large ballast water volumes at many U.S. ports (e.g., Valdez, Alaska, and Chesapeake Bay). These discharges can result in the introduction or spread of NIS within regions of the U.S. Prince William Sound, Alaska, provides an excellent example of NIS introductions through domestic ballast water transfer. The majority of Prince William Sound tanker traffic is domestic, with 95.8 percent from western U.S. ports (Hines and Ruiz 2000). To date, relatively little is known about the management and delivery of ballast water that originates and remains within the U.S. EEZ. This information gap precludes the formation of critical policy and management decisions. As a result, a discussion and evaluation of domestic ballast water transfer within the EEZ is not being addressed in this Programmatic Environmental Assessment (PEA).

Another vector is a No Ballast on Board or (NOBOB) vessel. NOBOBs are vessels that enter U.S. waters fully loaded with cargo. These vessels typically have ballast tanks holding unpumpable slop (sediment and water slurry) that may get resuspended and later discharged at subsequent port calls. Due to the current regulatory scheme, this is only reported to be an issue in the Great Lakes. Approximately 75% to 95% of the cargo laden vessels entering the Great Lakes report NOBOB status. Recent studies have shown NOBOBs to carry viable organisms in the sediment and residue ballast water, which are potential NIS. Since NOBOB vessels would not be carrying ballast water, they would not be required to engage in the mandatory BWM measures in this proposed rule. As a result, a discussion and evaluation of NOBOBs is not being addressed in this Programmatic Environmental Assessment (PEA).

Several other vectors, besides ballast water, exist for the introduction of NIS. NIS imported for aquaculture may escape farm containments and become established in U.S. waters. Fish and other organisms that are imported for private and public aquaria have the potential to escape or to be released from confinement. Discarding live seafood product, aquarium plants and animals, or other aquatic species by individuals contributes to NIS introductions. Recreational and commercial fishing industries may introduce NIS either accidentally (seafood imports) or intentionally (fish stocking). Research and teaching organizations often import NIS for testing and research, and improper handling can result in introductions (Elston 1997). In addition, vectors other than ballast water may be associated with shipping and boating activities. All vessels from small recreational boats to large commercial ships can contribute to the transport of NIS. Aquatic organisms can attach to boat hulls, trailers, anchors, and other compartments of commercial and recreational vessels.

While all of these vectors can lead to NIS introductions, the Proposed Action addresses only ballast water discharge. Because of our current inability to predict the course and trends of invasion biology, prevention or reduction of invasions is the most effective first line of defense against the impacts of aquatic bioinvasions (Gulf of Mexico Program 2002, Mack *et al.* 2000, Hay and Tanis 1998, U.S. Congress Office of Technology Assessment 1993, Aquatic Nuisance Species Task Force 2003). Limiting NIS introductions through BWM is a feasible and straightforward method for reducing the potential of NIS introductions to U.S. waters (http://www.anstaskforce.gov, accessed in January 2003).

1.4 Related Activities

The U.S. Coast Guard is concurrently addressing other NISA directives, which are not the focus of this PEA and are being developed separately. These projects include:

1. *Penalties for Non-Submission of Ballast Water Management Reports.* The U.S. Coast Guard proposed a rulemaking (68 FR 523, January 6, 2003) to impose penalty provisions for non-submission of Ballast Water Management Reports. This rulemaking also proposes widening the applicability of the reporting and record keeping requirements to all vessels bound for ports or places within the U.S., with minor exceptions. This rulemaking is being developed because the Report to Congress found that the reporting conducted by vessels was not adequate for the Secretary to assess compliance with the voluntary BWM guidelines.
2. *Approval for Experimental Shipboard Installations of Ballast Water Treatment Systems.* The U.S. Coast Guard is developing a program through which vessel owners can apply for approval of experimental ballast water treatment systems installed and tested onboard their operating vessels. This rulemaking will facilitate the development of effective ballast water treatment technologies,

and will aid in fulfilling the requirements of NISA to develop alternative ballast water treatment technologies.

3. *Standards for Living Organisms in Ship's Ballast Water Discharged in U.S. Waters.* The U.S. Coast Guard is developing a ballast water discharge goal and standard, both of which are essential parts of determining whether alternative BWM methods are environmentally sound and effective at preventing the introduction of NIS. NANPCA and NISA authorize the U.S. Coast Guard to approve alternate ballast water treatment methods that are found to be at least as effective as ballast water exchange in preventing and controlling introductions of NIS.

Introductions of NIS via ballast water discharge are an international concern. Currently, the U.S. Coast Guard is the lead U.S. government agency with the International Maritime Organization (IMO) in developing an international BWM program. The U.S. Coast Guard coordinates this effort with the U.S. Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Defense (DOD), the U.S. Maritime Administration (MARAD), the U.S. Department of Justice (DOJ), and the U.S. Department of State (DOS). The IMO is responsible for improving maritime safety and preventing pollution from ships, and is beginning to draft new guidelines for an international BWM program. The guidelines will involve mandatory requirements for a Ballast Water and Sediments Management Plan, a Ballast Water Record Book, and a requirement for all new vessels to conduct ballast water and sediment management procedures in accordance with various BWM standards. Additional requirements and procedures for special designations, where supplemental criteria and controls for ballast water discharge and uptake are needed, will be developed.

1.5 Environmental Evaluation

This PEA has been prepared in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended (P.L. 91-190). NEPA is intended to help public officials make decisions that are based on an understanding of environmental consequences, and to take actions that protect, restore, and enhance the environment. These decisions are to be made based on accurate scientific analysis, expert agency comments, and public scrutiny of readily available environmental information. Federal agencies are obligated to follow the provisions of NEPA to identify and assess reasonable alternatives to the proposed action that will avoid or minimize any adverse effects upon the quality of the human environment before proceeding with the proposed action.

The purpose of this PEA is to document the manner in which the U.S. Coast Guard considered the potential for impacts of the proposed rulemaking to the aquatic and human environment. The PEA contains an assessment of the potential for environmental impacts associated with requiring all vessels that have operated outside of the EEZ to conduct mandatory BWM. As previously discussed, there is currently a mandatory BWM program in place for the Great Lakes and Hudson River and a voluntary BWM program applicable to the entire U.S. This PEA examines the probable impacts of the proposed rulemaking based on reasonably foreseeable consequences, and also recommends measures to mitigate impacts, as appropriate. Based on the findings in this PEA, the U.S. Coast Guard will take one of the following two actions:

1. If it is determined that the Proposed Action will not have a significant impact on the aquatic and human environment, a Finding of No Significant Impact (FONSI) will be issued; or
2. If it is determined that the Proposed Action may have a significant impact on the aquatic and human environment, the U.S. Coast Guard will prepare an Environmental Impact Statement (EIS) to further analyze identified impacts.

2.0 ALTERNATIVES

2.1 Description of Alternatives

2.1.1 Alternative 1: No Action – Voluntary Ballast Water Management Guidelines

Under Alternative 1, BWM guidelines would remain voluntary as originally cited by NISA. Ballast water management and associated record-keeping and reporting, without penalty provisions, would remain mandatory prior to entering the Great Lakes (58 FR 18334, April 8, 1993) and the Hudson River north of the George Washington Bridge (59 FR 67632, December 1994). It is anticipated that low levels of compliance with the voluntary BWM guidelines would continue, resulting in increases in introductions of NIS via ballast water discharge. A proposed rulemaking establishing penalty provisions was published January 6, 2003. A final rule will be published in the near future.

Existing regulations require mandatory ballast water management for all applicable vessels bound for the Great Lakes or the Hudson River north of the George Washington Bridge that conduct all or part of their voyage beyond the EEZ. These rules, as finalized, are contained in 33 CFR 151 subpart C. Under the mandate of NISA 1996 to enhance the protection of aquatic resources, including reducing NIS introductions, 33 CFR 151 subpart D was revised to establish voluntary guidelines for all other U.S. waters requesting that ship's masters conduct BWM and associated reporting. These guidelines requested that vessels operating outside of the EEZ implement one of the following BWM practices.

1. *Exchange ballast water beyond the EEZ, in an area more than 200 nautical miles from shore and in waters more than 2,000 meters deep.* This refers to conducting mid-ocean ballast water exchange, exchanging ballast water obtained from ports or coastal waters outside of the EEZ with mid-ocean waters, prior to ballast water discharge in U.S. waters.
   A. *Empty and refill exchange*. Ballast water taken on in ports or coastal waters outside of the EEZ are discharged until the ballast tank is empty (as close to 100 percent empty as vessel navigation and safety considerations will allow). The tank is then refilled with mid-ocean water.
   B. *Flow through exchange*. Ballast water taken on in ports or coastal waters outside the EEZ is flushed out of the ballast water tanks by pumping in mid-ocean water at the bottom of the tank and continuously overflowing the tank from the top. This flushing continues until three full ballast water tank volumes have been pumped.
2. *Retain ballast onboard the vessel.* A vessel that does not choose to conduct mid-ocean exchange may elect to retain its ballast water onboard while in U.S. waters.
3. *Use an "environmentally sound" U.S. Coast Guard-approved alternative ballast water management method before the vessel enters the U.S. EEZ.* An alternative environmentally sound method of BWM is any method, effort, action, or program that will prevent and control NIS introductions during ballast water discharge. U.S. Coast Guard is in the process of developing a program for approving this type of ballast water management. This will be addressed in future rulemakings.
4. *Discharge ballast water to an approved reception facility*. An approved reception facility is a shoreside ballast water holding or treatment facility that is specifically used to accommodate ballast water discharge from vessels.
5. *Under extraordinary conditions, conduct a ballast water exchange within a geographic area agreed to by the COTP*. This practice allows the ship's master of any vessel, subject to weather,

equipment failure, or other extraordinary conditions, unable to conduct a ballast water exchange before entering U.S. waters, to employ another method of BWM. Specifically, the ship's master could request from the COTP, permission to exchange the vessel's ballast water within an area agreed to by the COTP.

Furthermore, the voluntary guidelines require vessels entering U.S. waters that have operated beyond the EEZ during any part of its voyage to maintain records and report vessel, voyage, and ballast water exchange/management information, and information on ballast water discharge to U.S. waters or facilities to the National Ballast Information Clearinghouse.

2.1.2 Alternative 2: Proposed Action – Mandatory Ballast Water Management Program

Under Alternative 2, the U.S. Coast Guard proposes a second and preferred alternative as the Proposed Action. Alternative 2 would revise 33 CFR 151 subpart D to require all vessels carrying ballast water into U.S. waters, after operating outside of the EEZ, to conduct one of four mandatory BWM practices prior to discharging ballast water into U.S. waters.

Under Alternative 2, the mandatory BWM program would include:

1. *Exchange ballast water beyond the EEZ, in an area more than 200 nautical miles from any shore.* This refers to conducting mid-ocean ballast water exchange, exchanging ballast water obtained from ports or coastal waters outside of the EEZ with mid-ocean waters, prior to ballast water discharge in U.S. waters.
   - A. *Empty and refill exchange*. Ballast water taken on in ports or coastal waters outside of the EEZ are discharged until the ballast tank is empty (as close to 100 percent empty as vessel navigation and safety considerations will allow). The tank is then refilled with mid-ocean water.
   - *B. Flow through exchange*. Ballast water taken on in ports or coastal waters outside the EEZ is flushed out of the ballast water tanks by pumping in mid-ocean water at the bottom of the tank and continuously overflowing the tank from the top. This flushing continues until three full ballast water tank volumes have been pumped.
2. *Retain ballast onboard the vessel.* A vessel that does not choose to conduct mid-ocean exchange may elect to retain its ballast water onboard while in U.S. waters.
3. *Use an "environmentally sound" U.S. Coast Guard-approved alternative ballast water management method before the vessel enters the U.S. EEZ.* An alternative environmentally sound method of BWM is any method, effort, action, or program that will prevent and control NIS introductions during ballast water discharge. U.S. Coast Guard is in the process of developing a program for approving this type of ballast water management. This will be addressed in future rulemakings.
4. *Discharge ballast water to an approved reception facility*. An approved reception facility is a shoreside ballast water holding or treatment facility that is specifically used to accommodate ballast water discharge from vessels.

Under Alternative 2, no vessel would be required to deviate from its voyage, or delay its voyage, to conduct a ballast water exchange. A vessel that cannot conduct ballast water exchange because its route does not enter waters 200 nautical miles or greater from any shore and/or because of safety concerns, would not be prohibited from discharging ballast water in U.S. waters, with the exception of the Great Lakes and the Hudson River. However, in this case, the vessel must discharge only an amount of ballast water that is operationally necessary, and, upon request, must provide documentation to the local COTP supporting its claim that it could not comply with the mandatory BWM requirements.

2.2 Description of BWM Practices of the Proposed Action

The Proposed Action addresses four BWM practices. The following section provides a brief overview of the four practices and their viability. In the development of this PEA, a substantial literature review was conducted relevant to BWM and related practices. Considerable literature regarding the ballast water exchange practice was available, however, literature addressing the other BWM practices was limited.

2.2.1 Efficacy of Mid-Ocean Exchange

Two measures are commonly utilized when monitoring and evaluating the efficacy of mid-ocean exchange: the volume of water that has been replaced in the ballast tanks and the removal of organisms from the ballast water tanks during the exchange process. Both measures of mid-ocean ballast water exchange have been the focus of many studies. Results of these studies vary greatly and are dependent upon vessel type, exchange method, ballasting system configuration and method of study. Studies suggest that the efficacy of water exchange is 80 to 99 percent per event (Hines and Ruiz 2000; Taylor and Bruce 2000; Dickman and Zhang 1999; Zhang and Dickman 1999; Smith *et al.* 1996; Rigby and Hallegraeff 1993). While the efficacy of organism removal has been documented to be 50 to 90 percent effective (USCG 2001). The results of selected ballast water exchange studies are presented in Table 1.

In the bioinvasions study of cold-water coastal ecosystems conducted from 1998 to 2000 in Port Valdez/Prince William Sound, Alaska, it was hypothesized that the effects of ballast water exchange combined with the length of the voyage, are responsible for decreasing densities of coastal organisms including cnidarians, flatworms, annelids, mollusks, cordates, echinoderms, bryozoans, and crustacean groups (Hines and Ruiz 2000). Locke *et al.* (1993) found a 67 to 87 percent exchange efficacy in removal of brackish-water-tolerant organisms from ballast water. Efficacy was calculated by the proportion of remaining brackish-water-tolerant organisms found in the ballast water after mid-ocean exchange. Studies using methlylene blue dye in ballast tanks, have shown a 95 percent efficacy, and a 75 to 95 percent (for the phytoplankton community) efficacy in ballast exchange, which involved flushing of ballast water through tanks for a continuous nine hours (equivalent to three tank volumes) (Wonham *et al* 1996). A reduction in concentrations of larvae and plankton by 50 to 90 percent remaining in ballast tanks was found by Smith *et al.* (1996) after mid-ocean exchange.

Thirty-four Orient Overseas Container Line (OOCL) vessels were studied by Dickman and Zhang (1999) from April 1996 to April 1997 on their way to Hong Kong from Oakland, California. Of the 14 vessels that exchanged their ballast water in mid-ocean waters, Dickman and Zhang (1999) found an 87 percent reduction in the total abundance of harmful dinoflagellates and diatoms, and an 83 percent reduction in the total dinoflagellate and diatom populations within the ballast tanks. A second study in June 1996 to January 1998 of three container vessels, traveling from Manzanillo, Mexico, to Hong Kong, found a 48 percent efficiency rate for mid-ocean exchange. These vessels were found to contain more sediment and encysted species prior to ballast water exchange than afterward.

Table 1. Results of Selected Ballast Water Exchange Efficacy Studies

Biotic Removal Efficacy	Water Exchange Efficacy (method)	Taxa	Exchange Type	Authors
87 harmful 83 total abundance	95-99 (stat.)	Diatoms Dinoflagellates	No data	Zhang & Dickman 1999
39 harmful 48 total abundance	95-99 (stat.)	Diatoms Dinoflagellates	No data	Dickman & Zhang 1999
95 no. organisms 99.9 coastal spinoids	87.8 (salinity)	Diatoms Dinoflagellates Zooplankton	No data	Smith *et al.* 1996
75-95 stained plankton	95 (dye)	Diatoms Dinoflagellates Copepods	Flow-through	Rigby & Hallegraeff 1993
67-86 ships of FW origin retaining FW taxa following mid-ocean exchange	No Data	Macrozooplankton	No data	Locke *et al.* 1991
100 Japanese copepods 84 copepods	No Data	Copepods Macrozooplankton	No data	Williams *et al.* 1988
90-100 total abundance	>95 (dye) ≥99 (dye)	Phytoplankton Macrozooplankton	Flow-through	Taylor & Bruce 2000
No Data	99 (salinity)	Diatoms Dinoflagellates Macrozooplankton	Empty Refill	Wonham *et al.* 1996
90 no. organisms	80-99	Phytoplankton Macrozooplankton	Empty Refill and Flow-through	Hines & Ruiz 2000

Source: Ad Hoc Workshop on Standards 2000, Hines and Ruiz 2000

stat. = statement within study
dye = calculation based on known dye concentration in ballast water prior to and after exchange
salinity = calculation using known salinities of ballast and ocean water
FW = fresh water
Note: Efficacy expressed as % removal of original water or organisms.

Removal of organisms is dependent upon a number of factors, including the two exchange methods: (1) empty and refill exchange, and (2) flow through exchange. Flow-through exchange initially has the effect of dilution, but not complete replacement of water as in the empty and refill exchange method (Hines and Ruiz 2000). To achieve a maximum exchange, multiple exchanges are recommended. The IMO standard recommendation is 300 percent or three full ballast tank volumes for flow through exchange, and 100 to 200 percent, or 1 to 2 ballast tank volumes, for empty and refill exchange. In theory, these recommended standards provide approximately 90 percent replacement of port water with oceanic water, but various vessel types and ballast water tank configurations have remained unstudied (Hines and Ruiz 2000).

Other variables affecting the efficacy of ballast water exchange include the amount and circulation of water being removed, the ability of some taxa to remain near the bottom of tanks or swim against currents, the taxonomic group examined, and the design of the study (Hines and Ruiz 2000, Taylor and Bruce 2000, Dickman and Zhang 1999, Smith *et al.* 1996, Rigby and Hallegraeff 1993). Some shipping routes actually lay in shallower water located near large rivers. In these cases, exchanges do not actually accomplish "mid-ocean" exchange and have the potential to replenish the ballast tank with unwanted NIS. In addition, salinity differentials may be lower, resulting in less efficiency at expelling the original organisms in the ballast water tanks (Taylor and Bruce 2000).

Residual water and sediment in the bottom of ballast tanks after a tank pump-out may contain more planktonic organisms than water from the surface of the ballast tank (Rigby and Hallegraeff 1993). Older container ships can carry accumulated sediment on the bottom of ballast tanks that is likely to be deposited on ledges, structural supports, and dead zones. Consequently, the remaining 1 to 5 percent of ballast water may contain an accumulation of life forms from ports around the world. The removal of all but five percent of the ballast tank volume may not rid the tank of potentially harmful species (Hamer *et al.* 2000, Dickman and Zhang 1999, Galil and Hülsmann 1997, NRC 1996, Rigby and Hallegraeff 1993, Locke *et al.* 1993, Hallegraeff and Bolch 1992). Hallegraeff and Bolch (1992) concluded that in 14 of 32 older vessels studied, following mid-ocean exchange, considerable numbers of dinoflagellate cysts remained. Dickman and Zhang (1999) studied newer OOCL vessels en route from Oakland, California, to Hong Kong, and found that more recent ballast water exchange designs made sediment discharge from ballast tanks highly efficient. They also estimated that 95 to 99 percent of source water from newer OOCL vessels are removed during mid-ocean exchange, after checking vessel ballast tank gauges. Where there was a homogenous distribution of organisms throughout the water column, removal of organisms in ballast exchange would be up to 95 to 99 percent effective (Dickman and Zhang 1999).

2.2.2 Retain Ballast Water Onboard the Vessel

A vessel that does not choose to conduct mid-ocean exchange may elect to retain its ballast water onboard while in U.S. waters. For example, newer ship designs have created fresh water ballast systems where a ship is able to retain ballast water onboard. Because no ballast water is discharged, there would be no risk of introducing NIS by ballast water.

2.2.3 Use an Alternative Environmentally Sound Method of BWM that has been Approved by the U.S. Coast Guard Before the Vessel Enters U.S. EEZ.

As demonstrated in the previous section, ballast water exchange may not be 100 percent effective. Therefore, use of onboard treatment technologies is generally thought to be a more effective long-term BWM alternative. There are many potential environmentally sound treatment technologies in the research and development stage, and there is considerable debate and conflicting information on the effectiveness and installation and / operating costs of these treatment technologies. Some treatment technologies are:

- Acoustic (ultrasonic) systems use transducers to convert electrical energy into vibratory energy of a specific amplitude and frequency. Exposure of aquatic microorganisms to ultrasonic treatment results in cellular disruption and organism death (Buchholz *et al.* 1998). Ultrasonic energy has been demonstrated to kill certain aquatic species including zebra mussels and Asian clams (Oliver 2000).
- Biocides, formerly known as non-agricultural pesticides, disinfect ballast water by killing bacteria, viruses, and other NIS. Particularly effective biocides are the oxidizing biocides such as chlorine, ozone, potassium permanganate, hydrogen peroxide, or bromine. Contact time of chlorine treatment in ballast tanks would be relatively long (days), therefore the amount of residual chlorine required to achieve a high percentage kill could be kept low. Ozone has been used for the control of microbial contamination in aquaculture, aquaria and power-plant cooling

systems since the 1970s (Buchholz *et al.*1998). Chlorination and oxidizing biocides are proven methods of disinfection in wastewater. Chlorinating ballast water en route to the ballast tanks is within present day technology (http://navyseic.dt.navy.mil/hot.htm, accessed January 2003). Non-oxidizing biocides may be an effective means of controlling NIS in ballast water, however the cost would be significantly more than the use of chlorination. Additional problems of non-oxidizing biocides are finding a biocide that is effective against the variety of organisms found in ballast water, and identifying a means of neutralizing the biocide prior to discharging it back into the environment (http://navyseic.dt.navy.mil/hot.htm, accessed January 2003).

- Deoxygenation involves the removal of oxygen from ballast water. Most NIS require oxygen for survival, with the exception of cysts, spores, and anaerobic bacteria, thus with the removal of oxygen most organisms are destroyed. Oxygen can be removed from water by purging with an inert gas or by binding oxygen to a chemical additive (National Research Council 1996).
- Microfiltration involves the installation of filters into ballast water pumps to filter sediment and biota prior to release of ballast water (http://navyseic.dt.navy.mil/hot.htm, accessed January 2003). This system could be installed during the construction of new vessels, however, it would be difficult to retrofit existing commercial vessels due to ship space constraints.
- Thermal treatment elevates the temperature of ballast water to destroy organisms. Most microorganisms are able to tolerate relatively high temperatures for short periods, and lower temperatures for longer periods (Buchholz *et al.* 1998). The use of thermal treatment to destroy dinoflagellates, that cause red tides, has proven effective (EPA 2001).
- UV radiation is a light energy. The exposure of some types of organisms to UV interrupts normal DNA replication and organisms are killed or rendered inactive. UV radiation as a disinfecting technique has been proven in multiple industrial applications, including drinking water disinfection and wastewater treatment (Buchholz *et al.* 1998).

While these methods may be potentially effective in destroying NIS entrained in ballast water, it has not yet been definitively determined that any one method is more viable than another. Additionally, as discussed in Section 1.4 Related Activities, the U.S. Coast Guard is currently working on alternative methods, which includes the development of an "Experimental Approval Program and Standards for Living Organisms in Ship's Ballast Water Discharged in U.S. Waters." Until viable treatment technologies and systems, and related treatment standards, are agreed upon, all these methods will continue to be in the research and development stage.

2.2.4 Discharge Ballast Water to an Approved Reception Facility

Two potential options have been developed for ballast water reception facilities: (1) introduction of ballast water to a facility that treats ballast water and discharges it in accordance with a National Pollutant Discharge Elimination System (NPDES) permit; and (2) introduction of ballast water to the facility where it would be stored and reused for ballasting purposes by other vessels. This BWM practice, however, is presently very limited, because there are only three onshore ballast water treatment facilities in operation in the U.S. Only one of these facilities currently has the potential to process ballast water containing NIS. The three facilities are the Alyeska Ballast Water Treatment Facility in Valdez, Alaska; the Cascade General Drydock in Portland, Oregon; and the San Francisco Dry Dock (SFDD) in San Francisco, California.

- The Alyeska Ballast Water Treatment Facility is an onshore ballast water treatment facility that receives ballast water from crude oil tankers. Tankers pick up oil from the Alaska pipeline and deliver it to ports along the West coast, and normally do not venture into the open ocean, thus precluding them from conducting mid-ocean exchange. The typical routine for an oil tanker entails traveling north to Alaska with the cargo tanks filled with ballast water. Upon arrival in Alaska, the vessel releases ballast water from the cargo tanks and fills them with oil (USEPA 2001). Tankers picking up crude oil at the Valdez Marine Terminal discharge their ballast water at the Alyeska Ballast Water Treatment Facility. The facility occupies 1,000 acres of land and cost $1.4 billion to build (USEPA 2001). This shore reception facility prevents oil-contaminated ballast water from entering Prince William Sound, and has the potential to eliminate the release of NIS.

- The Cascade General Drydock facility maintains two separate ballast water treatment plants situated on the Columbia River for treatment of non-segregated (ballast water carried in cargo tanks) and segregated (ballast water carried in ballast water tanks) ballast water from tankers. The ballast water is treated through two different systems and discharged under a NPDES permit (USEPA 2001). Neither system is designed for or could be used to treat ballast water for NIS (USEPA 2000).
- The SFDD facility performs vessel cleaning and repairs, and discharges from the facility can include ballast water and storm water associated with industrial activity at the facility. Because such discharges are potentially contaminated with chemical additives, oil and grease, particulates, and NIS, the permit prohibits discharge into San Francisco Bay (USEPA 2000). SFDD appealed the prohibition on the discharge of ballast water and sediments to the Bay. Because their permit for the local publicly-owned treatment works (POTW) prohibits the introduction to the POTW of saline water except in small quantities, the prohibition was stayed (USEPA 2000). The introduction of ballast water to POTWs is unlikely to be a viable treatment option (USEPA 2000).

A review of onshore oily ballast water treatment facilities in Valdez, Alaska, and dry dock facilities in Oregon and San Francisco Bay found that, while it may be possible to convert tanker terminal facilities to handle larger volumes of ballast water, there is little potential for the use of dry dock ballast water treatment systems (URS/Dames and Moore 2000).

The U.S. and other countries are conducting or considering studies to convert existing facilities and/or build facilities to treat ballast water. The feasibility of shore-based ballast water treatment options has been discussed in reviews of BWM technologies and is the subject of ongoing studies funded by several NOAA programs and the EPA Programs (EPA 2001). The following findings resulted from a study, conducted through the collaborative efforts of the California Association of Port Authorities (CAPA) and the EPA, to evaluate the feasibility of onshore ballast water treatment at California ports. These findings would likely be universal themes of the feasibility of shore-based facilities throughout the U.S.

- It would be feasible to retrofit vessels and wharves, construct onshore storage tanks and onshore treatment systems and discharge treated ballast water back to the ocean, provided cost is not a consideration and the treatment standards for existing wastewater treatment systems can be assumed to be representative of the standards required for organisms in ballast water (URS/Dames and Moore 2000).
- It would be feasible to treat ballast water discharged from retrofitted container vessels, but operational delays to bulk carriers and tankers that carry large volumes of water while loading cargo are likely. Operationally, it would not be possible to treat all ballast water discharge within the U.S. EEZ at onshore facilities without intermediary vessels or some other transportation system to collect ballast water that is currently discharged outside of ports. Safety would be of concern for at-sea transfers of ballast water (URS/Dames and Moore 2000).
- Economically, capital infrastructure cost would range from $7.6 million to $49.7 million for ports associated the CAPA. Operation and maintenance costs would range from $142,000 to $223,000

per year. Therefore, onshore treatment of ballast water is likely to cost at least $1.40 per metric ton of ballast water treated and as much as $8.30 per metric ton for California public ports, depending on port configuration and discharge volume. For other ports that handle a proportionally larger volume of bulk carrier and tanker traffic, the capital and operation and maintenance costs are expected to be higher. For comparison, the cost of mid-ocean exchange of ballast water, which is currently required for ships entering California from outside the EEZ is approximately $0.02 to $0.10 per metric ton (URS/Dames and Moore 2000).

The development of both onboard and shoreside ballast water treatment technologies and techniques is at an early stage. Given the stage of development of these treatment options, it is too early to consider significant investment in the onshore ballast water treatment option (URS/Dames and Moore 2000).

2.3 Alternatives Considered but not Further Analyzed

2.3.1 Ballast Water Discharge Standards

Ballast water exchange is currently the most commonly used BWM practice, however, it is not considered the optimal long-term practice to prevent introductions of NIS due to constraints on its implementation and effectiveness. For example, rough seas can prevent ballast water exchange due to vessel safety considerations. In addition, the time and costs involved with ballast water exchange make it a tedious and unpopular practice (Hay and Tanis 1998). For these reasons and because the efficiency and efficacy of ballast water exchange is highly variable, alternative management practices are being pursued nationally and internationally.

The U.S. Coast Guard continues to engage in a number of initiatives to establish quantitative ballast water discharge standards as described in Section 1.4 Related Activities. A notice and request for comments (66 FR 21807, May 1, 2001) was published on four possible approaches to setting standards. The request solicited input related to setting, implementing and enforcing appropriate standards. On March 4, 2002, the U.S. Coast Guard published an advanced Notice of Proposed Rulemaking, “Standard for Living Organisms in Ship’s Ballast Water Discharge in U.S. Waters” (67 FR 9632). The comment period for this proposed rulemaking has closed and the U.S. Coast Guard in now in the process of analyzing those comments.

The U.S. Coast Guard is planning to promulgate rules that will establish the process and guidelines for approval of onboard ballast water treatment systems. A request for comments entitled “Approval for Experimental Shipboard Installations of Ballast Water Treatment Systems” (66 FR 28213, May 22, 2001) was issued to request comments on how to provide incentives for further development of ballast water treatment technologies and systems. To assist in the development of a standards program, the U.S. Coast Guard has engaged in a cooperative effort with the EPA Environmental Technology Verification Program to develop protocols for testing, verifying and reporting on ballast water treatment technology performance.

Although concerted efforts have been focused on the development of quantitative standards, it is unlikely that standards will be established until 2004. As a result, this alternative for better controlling the introduction of NIS via ballast water discharge cannot be considered at this time.

2.3.2 Designated Ballast Water Exchange Locations within the 200 Nautical Mile Limit

There has been limited discussion regarding the establishment of designated ballast water exchange locations within 200 nautical miles from shore. A vessel could be directed to designated exchange locations in cases where it has not conducted ballast water exchange at least 200 nautical miles from any shore prior to entering a U.S. port. This alternative was not considered at this time since workshops on the west coast and east coast are currently taking place and are analyzing possible alternative exchange sites. When these studies are completed and available for detailed analysis this alternative will be examined in accordance with the existing regulatory scheme (33 CFR 151.1514 and 151.2035(b)).

3.0 AFFECTED ENVIRONMENT

3.1 Biological Environment

Both the Proposed Action and the No Action Alternative are directed at providing a national policy that addresses the impacts on U.S. waters of NIS introductions via ballast water management practices. The waters of the U.S. are a diverse assemblage of marine, estuarine, and freshwater ecosystems spread over an equally diverse assortment of regions. To address this issue at the national level it is useful to identify the regional and functional characteristics of these ecosystems. This section provides a general discussion of aquatic ecological principles, as well as a description of the basic functional components and regional variations that constitute the aquatic ecosystems of the U.S. Based on this description of aquatic ecosystems, the impacts of the two alternatives are compared in Section 4 Environmental Consequences.

3.1.1 Ecology of U.S. Waters

Ecosystems are composed of physical, chemical, and biological processes. The interaction of these processes creates a dynamic and interdependent relationship that defines the ecology of a system. Because ecosystems may be of any spatial or temporal magnitude, it is often useful to arbitrarily define boundaries to simplify ecological discussions. Listed below are the generally accepted divisions of major aquatic ecosystems (marine, estuarine, freshwater) with descriptions of their general characteristics and examples of key organisms.

Marine ecosystems are found along all coastlines of the U.S. and are defined by elevated salinity. Open ocean salinities are typically ~35 parts per thousand, while terrestrial freshwater influences result in a salinity of ~32 parts per thousand immediately along the coast. Within the coastal marine environment a variety of conditions exist.

Where the ocean meets the shore is the *intertidal zone*. Wave and tidal action make the intertidal zone a physically challenging place for species and, as a result, these communities are constantly changing. The upper intertidal zone is typically occupied by only a few species of algae and mollusks. Lower in the intertidal zone, in areas that are usually submerged during high tide, there is a more diverse array of algae and small animals, such as snails, crabs, sea stars, and small fishes. At the bottom of the intertidal zone, which is only exposed during the lowest tides, many invertebrates, fishes, and seaweed exist. Further from shore is open ocean, or the *pelagic zone*. The flora in the pelagic zone include plankton and surface seaweeds. The fauna includes many species of fish and some mammals, such as whales and dolphins, many of which feed on the abundant plankton. The *benthic zone* is the ocean floor under the pelagic zone. Benthic flora are represented primarily by seaweed, while the fauna, since it is very nutrient-rich, include many types of bacteria, fungi, sponges, sea anemones, worms, mollusks, crustaceans, sea stars, and fishes.

Marine systems are found in all regions of the U.S. and include many critical species. In the tropics and southern temperate areas, coral reefs and seagrass meadows are just some of the marine populations that play a crucial role in biodiversity and production. Other tropical species, such as shrimp and oysters, are valued for their commercial potential. Temperate marine ecosystems include an extremely wide variety of important species, including lobsters and cod on the East Coast, to salmon and crab on the West Coast and Alaska. In the arctic regions of Alaska, marine systems include critical plankton populations that form the trophic foundation for populations of fish and marine mammals including whales (e.g., beluga, bow head, narwhal) and seals (e.g., harp, ringed, and bearded). These species are important resources for native peoples, as discussed in Section 3.3.1.3 Tribal Fishing Rights.

Many marine systems have been highly invaded already by NIS. For example in the Gulf of Mexico ecosystem, hundreds of NIS across a variety of taxa have been identified including 483 plants, eight viruses, 50 invertebrates, and 38 fish (http://gsmfc.org/nis/nis/nis_alphabetic_list.html, accessed in January 2003).

Estuarine ecosystems are habitats where fresh and saline waters mix. These areas are characterized by changing salinities from tides and varying freshwater inputs. Estuaries also tend to have greater temperature variations than oceanic waters. As a result, estuarine species are characterized by their broad tolerance to fluctuations in the physical environment. Physical circulation patterns tend to retain nutrients that enter estuaries and benthic estuarine organisms are particularly effective at retaining, recycling, and mobilizing nutrients. As a result, estuaries are highly productive ecosystems. Estuaries play a critical role as nurseries for oceanic species including some commercially important fish and crustaceans. Species found in estuaries include algae, such as seaweeds, marsh grasses, and mangrove trees (in the tropics), and a diverse fauna, including a variety of worms, oysters, and crabs.

The size of estuaries varies greatly, and the numerous estuarine habitats of the U.S. are well distributed throughout the climate zones. Tropical estuaries include many unique species including mangroves, oysters, turtles, crocodiles, and the endangered West Indian Manatee (also found in freshwaters). The temperate U.S. coastlines include countless estuarine systems with thousands of associated species. U.S. waters also contain estuarine ecosystems in the arctic, including 10,000 acres of estuary in the Arctic National Wildlife Refuge. In addition, many U.S. shipping ports are located in estuaries, including, Boston Harbor, Providence Harbor, New York Harbor, Chesapeake Bay, Tampa Bay, Galveston Bay, San Juan Bay, Los Angeles, San Francisco Bay, Puget Sound, Pearl Harbor, and the Port of Valdez, Alaska.

San Francisco Bay has frequently been used for modeling of estuarine processes including NIS invasion rates and effects. By 1995, 212 NIS had been identified in this estuary. These NIS are spread across several groups of taxa: 69 percent are invertebrates, 15 percent fish and other vertebrates, 12 percent are plants, and 4 percent are protists. The number of NIS in the Bay may be even higher as another 123 species are considered cryptogenic (not clearly native or introduced). Since 1970 the rate of invasion in this area has been at least one new species every 24 weeks. NIS are found in every shallow water portion of San Francisco Bay, and in some areas NIS make up 100 percent of the aquatic community. Many of these NIS including the Asian Clam (*Potamocorbula amurensis*), the Atlantic green crab (*Carcinus maenas*), and over 30 species of fish dominate the food webs and have dramatically altered trophic functions in the bay. While San Francisco Bay has been recognized as the most invaded aquatic ecosystem in North America other large estuarine systems have also been highly invaded. Over 200 introduced and cryptogenic species have been identified in Chesapeake Bay (Fofonoff *et al* 1998).

Ballast water can be a major source of NIS introductions to estuarine systems. For example, a study of ballast tanks of ships 159 cargo vessels entering Coos Bay, Oregon, from Japan found at least 367 distinct taxa including plants, animals, and protists. Studies of ballast water entering Chesapeake Bay have found many taxa including barnacles, clams, mussels, copepods, diatoms, dinoflagellates, flatworms, and polycheate worms (CBC 1995, Carlton and Geller 1993).

Freshwater ecosystems include rivers, streams, lakes, ponds, and wetlands. The impacts of ballast water discharge are generally limited to port systems of larger lakes and rivers, such as the Great Lakes and the Mississippi River. However, the spread of NIS may have implications for smaller freshwater bodies. Lakes sustain a diverse community of species including plankton, rooted and floating aquatic plants, grazing snails, clams, insect larvae, crustaceans, fish, and amphibians. NIS have become a significant component of most trophic levels in the Great Lakes with 162 aquatic NIS identified as of 2001 (http://www.glerl.noaa.gov/res/Programs/nsmain.html, accessed in January 2003). In the Mississippi

River over 100 NIS have been identified across at least nine taxonomic groups (http://nas.er.usgs.gov/queries/huc2.html, accessed in January 2003). Rivers function as vital transportation corridors for both human activities and natural processes. Rivers transport nutrients from terrestrial systems into coastal areas, and as a result, the condition of rivers can have far-reaching implications. Rivers support a rich and diverse community of species. The Mississippi River alone provides habitat for 241 fish species, 37 mussel species, 45 amphibians, and 50 mammals (USEPA 2003). Lakes and rivers often also form the foundation for broader ecosystems beyond the boundaries of the shoreline. Many terrestrial birds, insects, and mammals depend on local freshwater ecosystems.

Tropical freshwater systems in the U.S. include the Florida Everglades, which contains flora such as sawgrass and swamp lily and fauna such as crayfish, bluegill, Florida gar, and alligator. The majority of freshwater systems in the U.S. are found in temperate climates. The two most significant systems are the Great Lakes and the Mississippi River and its associated watersheds. Thousands of species occupy U.S. temperate freshwater ecosystems. Recently, a great deal of attention has focused on freshwater NIS such as the zebra mussel, the ruffe, and the round goby.

Freshwater species in the U.S have been greatly impacted by NIS introductions, habitat destruction, and other human mediated factors. As a result the projected future extinction rates for freshwater fauna are approximately five times higher than for terrestrial fauna. These projected extinction rates fall within the estimated range for tropical rainforest communities. The freshwater fauna extinction rates for this century are estimated to be 1000 times higher than background rates determined from the fossil record (Ricciardi and Rasmussen 1999).

3.1.2 Biological Systems

Over time, the dynamic processes of an ecosystem produce changes to species-composition and to the physical-chemical environment. There is a tendency for ecosystems to progress towards a relatively stable equilibrium through a process of "succession." The introduction of a new species to an ecosystem can result in the breakdown of this equilibrium as functional roles are changed. Many U.S. aquatic ecosystems are already highly invaded and active succession may be more dominant than equilibrium in many areas. In these cases, the introduction of a new species may be disruptive as progress towards equilibrium is redirected. In fact, ecosystems may be particularly sensitive to disturbance and vulnerable to invasion during the early stages of succession when relatively few trophic pathways have been established. In extreme cases, this vulnerability can result in an "invasion meltdown" where NIS can eventually exclude all native species in an ecosystem (Carlton *et al.* 1995). The complexity of aquatic ecosystems means that NIS introductions at one trophic level can have far-reaching impacts across many other levels (Alpine and Cloern 1992).

These processes have serious implications for biodiversity. At the most basic level, NIS may reduce biodiversity by eliminating native species through competition, predation, or other mechanisms. At other times, introduced species may, in fact, increase the absolute number of species present in a given area. However, the original species and communities may have been altered or diminished altogether, and as a result, the "natural" biodiversity of a community or ecosystem has been reduced (Carlton 1996a). A substantial decline in abundance, diversity, and aesthetic value of biological resources can occur even when a NIS invasion does not result in the actual extinction of native species (Ruiz *et al.* 1997, U.S. Congress Office of Technology Assessment 1993). This biological sameness or simplification of ecosystems can have just as profound an effect on biodiversity as actual species numbers. NIS may also impact biodiversity through more complex or subtle means such as hybridization. Hybridization can result in less viable, or even sterile, offspring that compete for food resources without providing benefit or by decreasing reproduction. In addition, hybridization may genetically "swamp" a native species as each generation becomes more like the NIS (U.S. Congress Office of Technology Assessment 1993). The impacts of NIS on isolated or "island" populations can be exceptionally harmful. These localized populations often have narrow ecological requirements and are vulnerable to extinction (Carlton and Geller 1993, U.S. Congress Office of Technology Assessment 1993).

3.1.2.1 Microbes and Plankton

Microorganisms may constitute a numeric majority of the species found in ballast water (Carlton 2001, McCarthy and Crowder 2000, Carlton 1999a, Galil and Hülsmann 1997). Concentrations of bacteria and viruses in ballast water have been found at very high levels, suggesting that invasions may be relatively common (Drake *et al.* 2002, Drake *et al.* 2001). Phytoplankton, especially diatoms and dinoflagellates can be especially abundant (NRC 1996, Carlton and Geller 1993, Hallegraeff 1993). Plankton including those who spend their entire life-cycle in the water column (zooplankton) and species which spend only a portion of the life cycle in the water column (meroplankton) are common and diverse in ballast water (NRC 1996). The tendency to overlook the abundance and importance of microorganisms in ballast water may have contributed to an increase in frequency, intensity, and geographic distribution of harmful algal blooms (HABs) over the past few decades (Carlton 1999a, Hallegraeff 1993). In addition, human pathogen microbes are common in coastal waters and have been found in the ballast water of ships (Ruiz *et al.* 2000b, McCarthy and Khambaty 1994, Grimes 1991). Impacts of pathogens are discussed separately in section 3.3.1.2. Risks to Public Health.

Thousands of species make up the microbial community of U.S waters, freshwater, estuarine, and marine ecosystems each contain a wide variety of microorganisms. While microorganisms constitute a vital foundation for most aquatic ecosystem food webs, it is often difficult to conduct an accurate assessment of species abundance and composition. However, examples of such surveys provide insight into the diversity and abundance of the microorganisms throughout the U.S. One such survey conducted over a ten year period (1983 - 1992), identified 543 phytoplankton species from 145 genera, and 71 zooplankton species from 38 genera in the offshore waters of Lake Michigan (Makarewicz *et al.* 1994). Planktonic organisms are dominated by the phytoplankton group of diatoms. Several comprehensive surveys have been conducted for particular ecosystems and highlight the extent of diatom and phytoplankton abundance. Diatoms alone represent at least 1,823 taxa in the Great Lakes and 341 species in the Corpus Christi Bay area of Texas (Stoermer *et al.* 1999, Tunnell *et al.* 1996).

3.1.2.2 Invertebrates

The invertebrate populations of the U.S. are extensive and span a wide variety of groups including macroinvertebrates such as mollusks and crustaceans, but also including many microorganisms and plankton as discussed in Section 3.1.2.1 Microbes and Plankton. Macroinvertebrate species have been the focus of some of the most widely publicized cases of aquatic NIS. The establishment of mussels, clams, oysters, crabs, jellyfish, whelks, snails, and others in U.S. waters has had enormous ecological and economic impacts (Carlton 1999a, Carlton 1996a, Alpine and Cloern 1992, Carlton 1992). The establishment of the zebra mussel in the Great Lakes in the 1980s precipitated Federal attention to aquatic NIS. The Asian shore crab, green crab, and Eastern oyster have been used as models for understanding NIS introduction patterns and success (Grosholz *et al.* 2000, Lohrer *et al.* 1999, Carlton and Mann 1996, Grosholz and Ruiz 1996). Invertebrate species have shown remarkable success at establishing themselves and thriving in new environments. Several case studies in Appendix A, Representative NIS and Case Studies, address the extensive effects of invertebrate NIS introductions.

Ecologically, invertebrate NIS have had severe impacts in many regions of the U.S. For example, in San Francisco Bay the Asian clam has reached densities of >10,000 per m^2 at the expense of native biota (Carlton 1992). The elevated densities of this and other introduced invertebrates have become the primary mechanism for controlling phytoplankton biomass in portions of the Bay. This disruption of the food web foundation has, in turn, impacted zooplankton, shrimp, and fish populations (Cohen and Carlton

1995). Such breakdowns of established ecosystems can result in alterations of physical processes as well, such as sedimentation rates and nutrient cycling. Further impacts to the physical environment can also come from direct invertebrate activities. Many burrowing invertebrate NIS (e.g., isopods, crayfish, and crabs) have been implicated in elevated erosion rates (Cohen and Carlton 1995). Economic impacts associated with invertebrate biofouling of recreational and industrial systems have been widespread, the greatest example of which is the zebra mussel (see Section 3.3 Socioeconomic Environment).

There have been extensive introductions of marine and estuarine mollusks throughout North America since the early 19th century. Thirty species have become established on the Pacific Coast, eight on the Atlantic Coast, and one on the Gulf Coast (Carlton 1992). However, the number of mollusk species which were introduced but not yet verified as established in the U.S. exceeds 150 (http://nas.er.usgs.gov, accessed in January 2003). Invertebrate communities in the U.S. have already been impacted as result of NIS introductions and habitat loss. For example, 71.7 percent of the 297 native mussel species in the U.S. are considered endangered, threatened, or of special concern. This includes 35 species which have become extinct since 1900. It is estimated that unless effective conservation efforts are implemented another 127 freshwater mussel species will become extinct in the next 100 years. This is a conservative estimate that does not include a growing number of competitive and ecological impacts of the zebra mussel (Ricciardi and Rasmussen 1999, Williams and Neves). It is likely that other aquatic invertebrate groups have suffered the same impacts, although less research has been conducted on these trends.

3.1.2.3 Fishes

Fish may not be as numerically abundant in ballast water as compared to other phyla groups (Wonham *et al.* 2001). Their generally larger size and ability to swim away from intake ports may help them avoid entrainment in ballast tanks. However, it is these same traits that may contribute to their large impact on native systems once introduced. Once established in a new environment, fish can spread over broad geographic areas. A classic example is the Eurasian ruffe (*Gymnocephalus cernuus*), which was introduced via ballast water to the St. Lawrence River in the mid-1980s. Since its introduction, it has spread rapidly through rivers, bays, and lakes in the Great Lakes area. The ecological and geographical expansion of the ruffe has come at the expense of native fish populations, especially yellow perch, emerald and spottail shiners, trout perch, and brown bullhead. Similar declines in commercially valuable fish as a result of ruffe introductions have been seen in Scotland and Russia (U.S. Congress Office of Technology Assessment 1993). Other nonindigenous fish, such as the round goby (*Neogobius melanostomus*), have also spread rapidly following their introduction to U.S. waters. Appendix A – Representative NIS and Case Studies, presents several nonindigenous fish case studies.

The National Marine Fisheries Service (NMFS) monitors the status of over 800 commercially important marine fish stocks which have a substantial portion of their stock within the EEZ. These stocks are distributed throughout all regions of the U.S. and include menhaden, cod, haddock, and flounder in the North-/mid-Atlantic, shrimp in the Gulf of Mexico, mackerel and sardine in southern California, rockfish, lingcod, hake, and sole in the Pacific Northwest, and salmon, pollock, cod, halibut, and king crab in Alaska (NMFS 1998).

The U.S. Geological Survey (USGS) currently lists 679 nonindigenous fishes from 82 different families in the U.S. (http://nas.er.usgs.gov, accessed in January 2003). While many of these species have been introduced from one region of the U.S. to another, 39 percent have been introduced from foreign sources. In certain states such as Florida (82 percent) and Hawaii (50 percent) foreign sources dominate fish introductions. Of the 30 extinct fishes in the United States, nonindigenous species were a factor in the extinction of 24 (Fuller, 1999).

While ballast water may not be the primary source of fish introductions, as compared to intentional stocking, bait release, and private aquarium releases, severe nonindigenous fish impacts have resulted from ballast water discharge. Due to the substantial economic and social importance of fish stocks, the protection of native species is critical. Additionally, fish frequently fulfill a critical “top-down” function in ecosystems, and disruption at this trophic level can quickly alter processes throughout an entire ecosystem. In addition to ecosystem effects, fish have considerable economic and social value. Recreational and commercial fisheries (both capture and aquaculture) contribute economic and social functions in many U.S. communities. Even minor fluctuations in fish numbers, species composition, and health can have widespread effects on local communities and regional economies.

3.1.2.4 Marine Mammals

The Marine Mammal Protection Act (MMPA) of 1972 identified marine mammals as internationally significant, aesthetic, recreational, and economic resources. Under the MMPA, Congress intended that marine mammals “be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management and that the primary objective of their management should be to maintain the health and stability of the marine ecosystem.”

Approximately one-half of the world's marine mammal species occur within the territorial waters of the U.S. These include a variety of pinnipeds (seals and sea lions), and cetaceans (whales and dolphins) as well as the sea otter, polar bear, and manatee. Currently, NMFS has defined a total of 145 cetacean and pinniped stocks in U.S. waters:

- 60 in the Atlantic Ocean and Gulf of Mexico,
- 54 along the Pacific Coast of the continental United States and Hawaii, and
- 31 in Alaska and the North Pacific.

These stocks are defined by the MMPA as a group of marine mammals of the same species or smaller taxa in a common spatial arrangement, that interbreed when mature, with some species comprising multiple stocks.

3.1.2.5 Submerged and Emergent Plants

There is relatively little research published on ballast water mediated transport of plant species. However, it is known that floating and detached seaweeds and seagrasses may easily be entrained in ballast water (National Research Council 1996) and the consequences of nonindigenous aquatic plants have been extensive. Aquatic plants serve many critical functions in marine, estuarine, and freshwater ecosystems. Plants act as a food source and nutrient cycling mechanism. They frequently function as essential habitat for juvenile or other vulnerable organisms. Aquatic plants are also critical to physical systems by controlling erosion. The introduction of NIS has deleterious effects on native aquatic plants as well as serious implications for whole ecosystems even beyond the aquatic level.

Extensive seagrass beds exist in many U.S. ecosystems. For example, the total seagrass coverage in protected estuaries and nearshore waters of the Gulf of Mexico is estimated to be 2.52 million acres and the seagrass bed that carpets 80 percent of the Florida Keys National Marine Sanctuary is part of the largest documented contiguous seagrass bed in the world. Serious declines have been measured in many areas. In the northern Gulf of Mexico most estuaries have lost 20 to 100 percent of their seagrass coverage over the last five decades, and only a few areas have experienced increases in seagrasses. These losses have generally been attributed to human activities. For instance, based on a historical estimate, seagrasses in Tampa Bay covered 76,527 acres before human influence. By 1981, Tampa Bay seagrasses had suffered an estimated 81 percent reduction attributed primarily to direct dredging of seagrass beds and major shoreline modifications (Handley 1995).

Species such as Caulerpa algae (*Caulerpa taxifolia*), smooth cordgrass (*Spartina alterniflora*), and hydrilla (*Hydrilla verticillata*), although not introduced through ballast water, are excellent examples of the potential consequences of nonindigenous plant introductions. Smooth cordgrass, a native of the U.S. East Coast, has invaded numerous estuaries on the West Coast. The potential adverse impacts of this species include competitive replacement of native cordgrass; altered habitat for wetland animals and infauna including benthic algal communities; altered sediment dynamics; and loss of shorebird foraging habitat (Callaway and Josselyn 1992). In addition, hybridization of smooth cordgrass with native populations of cordgrass (*S. maritima*, in Britain) has produced a highly invasive cordgrass species (*S. anglica*) (Mack *et al.* 2000). Caulerpa algae, accidentally introduced in the Mediterranean Sea in the early 1980s, rapidly expanded to cover nearly 25,000 acres across six countries (Dumay *et al.* 2002, Meinesz 1999). *Caulerpa* has recently been observed on the West Coast of the U.S. There is growing concern that *Caulerpa's* strong interspecific competition for light and nutrients as well as its toxic properties (Dumay *et al.* 2002) will result in widespread establishment in U.S. waters. Hydrilla may be the most problematic nonindigenous aquatic plant in the U.S. Introduced and established on all coasts of the U.S., hydrilla forms dense mats that interfere with commercial, recreational, and ecological systems including boating, irrigation, and fish and wildlife habitats. These examples indicate the extent to which aquatic plant NIS can impact native ecosystems. The direct economic costs associated with controlling and managing these and other aquatic plant NIS, have been tremendous. Losses of habitat and native species result in additional and more complex economic implications.

Aquatic plant invasions in the U.S. are occurring at very high rates. In Florida alone, twenty-one nonindigenous aquatic plant species have become established. Many of these species such as hydrilla, waterlettuce (*Pistia stratiotes*), alligatorweed (*Alternanthera philoxeroides*), torpedograss (*Panicum repens*), and waterhyacinth (*Eichhornia crassipes*) are extremely invasive (McCann *et al* 1996). The Florida Exotic Pest Plant Council lists 11 of these 21 plants waters as Category I pest plants capable of completely disrupting aquatic ecosystems (FDEP 2001). Other systems are similarly invaded. In the San Francisco Bay estuary over twenty nonindigenous plant species have been identified (Cohen and Carlton 1995).

3.1.3 Threatened and Endangered Species

Introduced NIS have been cited as the second largest threat to endangered species after habitat loss (Wilcove and Chen 1998). Considering that NIS frequently contributes to habitat loss, the indirect impacts of NIS to threatened species may be even greater. The U.S. Fish and Wildlife Service (USFWS) currently lists 115 fish as "protected" based on their threatened or endangered status. The USFWS considers NIS a significant contributing factor in determining the "threatened" or "endangered" status of many native species (Ruiz *et al.* 1997, U.S. Congress Office of Technology Assessment 1993).

Cohen and Carlton (1995) provide an excellent example of the interconnectedness of ecosystems and impacts of NIS on endangered native species: "The situation of the California clapper rail (a shorebird) may serve as a model to assess how an endangered species may be affected by biological invasions. The rail suffers predation by introduced Norway rats and red fox; it may both feed on and be killed by introduced mussels; and it may find refuge in introduced cordgrass, although this same cordgrass may compete with native cordgrass, perhaps preferred by the rail."

The effects of nonindigenous fishes on endangered species and aquatic biodiversity is predicted to increase during the next 25 years because of the drastic increase in introduced fishes. Between 1950 and 1995, more than 458 fish species were introduced into the United States (Fuller, 1999).

The Endangered Species Act (ESA) of 1973 was enacted to conserve threatened and endangered species and their habitats. Therefore, in accordance with ESA, the U.S. Coast Guard has initiated an informal consultation with the USFWS and the NMFS. The purpose of the consultation is to identify threatened and endangered species and conduct coordination between the U.S. Coast Guard, USFWS, and NMFS to make all attempts to protect and conserve any threatened or endangered species and their habitats. Additionally, the Marine Mammal Protection Act (MMPA) of 1972 identified marine mammals as internationally significant, aesthetic, recreational, and economic resources. Under MMPA, Congress intended that marine mammals "be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management and that the primary objective of their management should be to maintain the health and stability of the marine ecosystem." In the sense that NIS may disrupt aquatic ecosystems and that these impacts may be felt at all levels of an ecosystem, NIS may be considered a threat to marine mammals.

3.1.4 Essential Fish Habitats

The importance of essential fish habitats (EFH) to the economy and ecology of the nation has been recognized by Congress under the Sustainable Fisheries Act (SFA) of 1996 (16 U.S.C. 1801 et seq.). The SFA mandates the identification of habitats essential to Federally managed marine finfish and shellfish species and the identification of measures to conserve and enhance these habitats. The SFA defined ESH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." This also extends to aquatic areas and the associated physical, chemical, and biological properties needed to support sustainable fisheries and healthy ecosystems.

Numerous examples of NIS threats to EFH have been discussed in this PEA. Nonindigenous aquatic plants can destroy EFH either directly or indirectly. The presence of HABs can disrupt EFH in a variety of ways including the reduction of light in the water column resulting in declines of seagrasses densities. Nonindigenous invertebrates can alter whole ecosystems including physical and chemical processes critical to EFH.

3.2 Physical and Chemical Environment

3.2.1 Physical Environment

Salinity, temperature and turbidity are key factors in how ecosystems are defined and how they function. The physical conditions of waters taken up during ballasting frequently do not match those of the system into which ballast water is discharged. Although exceptionally large volumes of ballast water can be discharged, these single-pulse volumes are typically minor when compared to the overall volume and flushing characteristics of most ports. Thus, it is unlikely that ballast water discharges will greatly impact the salinity, temperature or turbidity of receiving waters.

The wide-range of temperatures in both foreign and U.S. port waters means that discharged waters may or may not be of similar temperature to the receiving waters. If the discharged water is greatly dissimilar to that of the receiving environment there may be short-term detrimental effects to organisms in the immediate discharge area.

The discharge of ballast water can also create elevated turbidity in the surrounding waters. This may be caused either by the discharge of sediments in the ballast tanks or by stirring up bottom sediments near the vessel. Because mid-ocean water has very low suspended particulate loads, ballast water exchange may reduce the amount of particulate material in the ballast tanks, although the ballast tank configuration affects whether sediments are easily flushed during mid-ocean exchange, or held in the tanks.

3.2.2 Chemical Environment

As compared to mid-ocean waters, port waters, especially in highly-urbanized or industrialized areas, may have elevated concentrations of nutrients and/or toxic substances (e.g., metals and anthropogenic organic chemicals). It is possible that these constituents may be taken up in ballast water. Elevated nutrient concentrations in discharged ballast water may contribute to the stimulation and growth of both native and nonindigenous species. Toxins may have the opposite effect on both native and nonindigenous species resulting in increased mortality rates. Unlike ports, mid-ocean waters typically have low nutrient concentrations and very low contaminant levels.

3.3 Socioeconomic Environment

3.3.1 Socioeconomic Impacts of NIS Introductions via Ballast Water

The introduction of NIS via ballast water discharge and subsequent invasions of native aquatic ecosystems have demonstrable adverse impacts to economic systems, and potential adverse impacts to tribal fishing rights and public health. For example, bioinvasions of native aquatic ecosystems can adversely impact established economic systems dependent on ecosystem services, such as commercial and recreational fisheries. Disruptions to industrial and municipal processes, for instance, the clogging of raw water intake pipes by nonindigenous bivalves, can slow or halt production and generate associated control costs. In fact, the lack of NIS control programs could produce long-term financial burdens as researchers believe that once an aquatic NIS becomes established, eradication is almost impossible in large aquatic ecosystems (Benson 2000, Mack *et al*. 2000).

Studies of the socioeconomic impacts of aquatic NIS introductions are difficult to perform (Randall and Gollamudi 2001) and currently sparse. In-depth studies of the economic impacts of bioinvasions sourced to ballast water discharge center primarily around one species, the zebra mussel. Likewise, while the introduction of bacteria and viruses through ballast water is a growing concern (Associated Press 2000), potential public health impacts remain virtually unexplored by scientists (Ruiz *et al*. 2000b). The sections below present data that are available, however, quantification of actual impacts to economic systems, and a reliable assessment of public health risks remains problematic.

3.3.1.1 Economic Systems

NIS introductions have both adversely and positively impacted local, regional, and national economies. For example, recreational fishing, greatly enhanced by introductions of NIS, contributes $69 billion annually to the U.S. economy (U.S. Congress Office of Technology Assessment 1993). At the same time, accounting for only selected adverse ecological effects, Pimentel *et al* (1999) estimates overall economic losses due to invasive fish introductions at more than $1 billion per year. While there are economic benefits associated with managed and monitored introductions of NIS (e.g., recreational fish species, biocontrol agents), it is generally agreed that unintended, uncontrolled introductions with no appropriate assessment of risk – as is the case with ballast water discharge – result in detrimental rather than beneficial impacts (Gulf of Mexico Program 2002). However, some beneficial impacts may occur with these introductions, for example, while there are a growing number of studies attempting to quantify the costs associated with zebra mussel impacts to infrastructure and fisheries in the Great Lakes region, researchers determined that increased water clarity in Lake Erie due to water filtration by zebra mussels might enhance boating, swimming, and scuba diving activities (Hushak 1997). However, better water quality in the Great Lakes has subsequently made invasion more likely (National Research Council 1996).

Studies and anecdotes of adverse economic impacts caused by NIS via ballast water are presented in the following listings. One important note about this discussion is that most available studies and anecdotes only attempt to address the costs associated with established economic systems. In other words, the inherent value of native ecosystems and biodiversity, as well as aesthetic, cultural, and social attributes not readily valued in our current economic system, are not addressed in the available literature. For instance, studies have not attempted to quantify the future economic costs of declines in fish species that do not constitute a commercial or recreational fishery. Likewise, no special attention has been given to the impact of NIS to cultural and social systems. For example, a bioinvasion by a nonindigenous fish species could force local fishermen to seek other employment, eventually altering the social culture of the region as work shifts away from traditional occupations. Associated societal costs are difficult to measure.

Impacts to Water-Dependent Infrastructure

Invasive invertebrates introduced via ballast water discharge, such as the zebra mussel, have adversely impacted water-dependent infrastructure by biofouling intake pipes and screens, causing equipment malfunction and overheating, and jamming valves and other mechanisms. These impacts have affected electric power generation stations, drinking water treatment plants, industrial facilities, and navigation lock and dam structures. The organisms highlighted below are probable examples of introduced NIS via ballast water discharge.

- 339 facilities – including marinas, recreational facilities, hospitals, colleges, impoundments and reservoirs, fish hatcheries and aquaculture facilities, navigation locks, shipping companies, public agencies, industries, drinking water treatment facilities, and electric power generation facilities – in the Great Lakes region reported total zebra mussel-related expenses of over $69 million (a mean expenditure of $206,000 per facility) from 1989 through 1995 (O'Neill 1997). Total annual expenditures at these facilities increased from $234,000 in 1989 to over $17 million in 1995 (O'Neill 1997).
- Fouling damage from the Asian clam is estimated to be about $1 billion per year (U.S. Congress Office of Technology Assessment 1993).
- In the summer of 1998, local authorities had to deal with as many as 30,000 adult Chinese mitten crabs migrating downstream in the Sacramento River delta, which clogged the fish filtering and trash screens at the Tracy irrigation pumps every day (Carlton 2001, Congressional Research Service 1999).
- The brown mussel (*Perna perna*) has caused limited fouling damage along the Western Gulf Coast (Congressional Research Service 1999).
- The green mussel (*Perna viridis*) is established in Tampa Bay, and is currently causing biofouling problems at power plant cooling water intakes (Gulf of Mexico Program 2001).

Impacts to Commercial Fishing, Recreational Fishing, and Water-Dependent Tourism

Invasions of NIS can disrupt commercial (both capture and culture) and recreational fisheries, thereby adversely impacting local and regional economies. Similarly, water-dependent tourism and recreational activities associated with fishing, boating, swimming, and scuba diving, can be degraded by NIS, also impacting local and regional economies.

- Invasive fish species such as the sea lamprey, European ruffe, and round goby, threaten native sport fish populations in the Great Lakes (e.g., lake trout, walleye, yellow perch, and catfish), fisheries with an estimated value of $4.5 billion annually, supporting 81,000 jobs (Aquatic Nuisance Species Task Force 2003). The Great Lakes Fishery Resource Restoration Study (Burkett *et al.* 1995) determined that the entire Great Lakes fishing industry is valued at $6.89 billion, supporting 75,000 sport fishing-related and 9,000 commercial fishing-related jobs.
- Ohio's $600 million Lake Erie sport fishery lost 50 to 65 percent of its value between 1985 and 1995. Possible reasons include an above capacity walleye population in the early 1982, a rapidly

growing white perch population from 1985 to 1993, and the zebra mussel (Hushak 1997).

- There is concern that the Asian Carp may harm sport and commercial fisheries in the Great Lakes, and the U.S. Army Corps of Engineers constructed an underwater electric barrier in the Chicago Sanitary and Ship Canal to prevent its spread into the Mississippi River watershed (Congressional Research Service 1999). Federal funding alone for the project is $1.2 million (Glassner-Shwayder 1999).
- The annual estimated economic damage of the European green crab to shellfish production in the U.S. – including clams and oysters – is about $44 million (Congressional Research Service 1999).
- The spiny water flea (*Bythrotrephes cederstroemi*) may impact recreational species such as the yellow perch in the Great Lakes (Congressional Research Service 1999, Glassner-Shwayder 1999).
- The fishhook flea (*Cercopagis pengoi*) fouls fishing lines for both recreational and charter boat anglers. The long, spiny tail of this crustacean can become entangled on fishing lines in clumps of hundreds of individuals, and anglers, unable to reel in their lines, have resorted to cutting them off (Glassner-Shwayder 1999).
- The economic value of Ohio's artificial reefs could be greatly reduced if they become populated by the European ruffe; for example, the Lorain County reef generated an estimated economic value of $250,000 in 1992 (Hushak 1997).
- Zebra mussels biofoul boat hulls, increasing drag and increasing fuel costs. Cooling water intake ports on boat motors can also become fouled, causing engines to overheat.
- Nonindigenous aquatic plants such as hydrilla, water hyacinth, and water lettuce are altering fish habitat, choking waterways, altering nutrient cycles, and reducing recreational use of rivers and lakes (Pimental *et al.* 1999).

Required Control and Management Efforts

Universally, it is recognized that the prevention of new introductions of NIS, and the immediate eradication of new colonies of NIS, is the most effective and cost effective, method to control bioinvasions (Mack *et al.* 2000). Control activities are usually site-specific, and several methods are usually necessary (Benson 2000), resulting is extensive direct expenditures.

The U.S. General Accounting Office (GAO) recently surveyed 10 Federal departments to determine national expenditures on NIS activities (both terrestrial and aquatic). Eight agencies on the Invasive Species Council – representing the Departments of Agriculture, Commerce, Defense, Interior, State, Treasury, and Transportation, and the EPA – as well as the Smithsonian Institute and the National Science Foundation, collectively spent $513.9 million in Fiscal Year (FY) 1999 and $631.5 million in FY 2000 for the management and control of NIS (GAO 2000). Prevention of the NIS introductions received the largest percentage of funding – about 51 percent and 49 percent in FY 1999 and FY 2000, respectively (GAO 2000). The GAO also surveyed seven states – California, Florida, Hawaii, Idaho, Maryland, Michigan, and New York – to determine selected state expenditures on NIS activities. Florida spent the most at $94.5 million and $127.6 million in 1999 and 2000, respectively, on managing and controlling invasive terrestrial and aquatic species (GAO 2000). California reported the second highest expenditures at $82.6 million and $87.2 million in 1999 and 2000, respectively (GAO 2000). The costs of controlling and managing NIS introduced via ballast water discharge are not itemized in the GAO study; however, the following studies and anecdotes shed some light on associated costs.

- The USFWS has developed a detailed management strategy to control the spread of zebra mussel and other NIS west of the 100th meridian. The cost of this strategy is proposed at $5 million over 5 years (Mangin 2001).

- Control and research costs for the Chinese mitten crab included $1 million in Federal funds from 2000 to 2001 (Carlton 2001).
- Control and monitoring costs for the Mediterranean green seaweed (*Caulerpa taxifolia*) in southern California was $2.33 million in 2000-01 (Carlton 2001).
- Florida's Aquatic Plant Management Section currently manages the control of 11 nonindigenous aquatic plants in Florida's 1.3 million acres of public waters: hydrilla, water hyacinth, water lettuce, aquatic nightshade, giant salvinia, hygrophilia, paragrass, torpedograss, waterspinach, West Indian marshgrass, and wild taro (Schardt and Ludlow 2000). The Section's budget was increased from approximately $10 million to $25 million for FY 2001.
- Increased funding is required for management of species endangered or threatened by NIS (Wilcove and Chen 1998).
- The increase of harmful algal blooms as a result of NIS introductions may result a whole suite of economic impacts (Hallegraeff 1993).
- In the Great Lakes, over $10 million is spent annually on chemical sea lamprey control (Jude *et al.* 2002). Additionally, approximately $3 million annually is provided to the U.S. Army Corps of Engineers to dramatically reduce sea lamprey infestations with an emphasis on nonchemical alternatives through the use of sea lamprey barriers (Great Lakes Commission 2001).

3.3.1.2 Risks to Public Health

Concentrations of bacteria and viruses in ballast water may be six to eight times higher than those of other taxonomic groups (Ruiz *et al.* 2000b, Carlton and Geller 1993). During the 1997 and 1998 shipping seasons, samples were taken from the ballast tanks of 28 transoceanic vessels (Knight *et al.* 1999, Reynolds *et al.* 1999, Zo *et al.* 1999). The sampling revealed the presence of a host of microorganisms, many of which are human pathogens, including fecal coliforms, fecal streptococci, clostridium, salmonella, *E. coli*, *Vibrio cholerae*, crytosporidium, giardia, and enteroviruses. The presence of these organisms demonstrated the survival of human pathogens during transoceanic transport of ballast water. It remains unclear whether these species can survive and become successfully established following ballast water discharge, thereby becoming vectors for human exposure.

In 1991, during routine monitoring, the U.S. Food and Drug Administration (FDA) isolated *Vibrio cholera* O1 (the bacterium responsible for human cholera) from oysters and oyster-eating fish in Mobile Bay, Alabama (Drake *et al.* 2001, Eichold *et al.* 1993). Shortly after, a study by Ruiz *et al.* (2000b) examined the presence of bacteria in the ballast water of ships entering the Chesapeake Bay from foreign ports. This study measured overall bacteria counts and also specifically targeted the bacteria *Vibrio cholera* O1 and O139. *Vibrio cholerae* was found in all of the vessels sampled and both serotypes were detected in 93 percent of the ships. Risks of human exposure from ballast water discharges containing *Vibrio cholerae* are unknown.

The global increase in HABs via ballast water discharges poses an increased risk to human health. Many algal species contain powerful toxins which can affect fish, birds, and humans through the consumption of fish and shellfish. Paralytic shellfish poisoning, diarrhetic shellfish poisoning, amnesic shellfish poisoning, and ciguatera are associated with toxins contained in HABs. Human ingestion of these toxins can result in symptoms ranging from nausea and dizziness to tumors, short-term memory loss, muscular paralysis, and even death from respiratory failure (Hallegraeff 1993).

3.3.1.3 Tribal Fishing Rights

Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, was established to conduct regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications; to strengthen the U.S. government-to-government relationships with Native American tribes; and to reduce the imposition of unfunded mandates upon Native American tribes. Policies that have tribal implications refer to regulations, legislative comments or proposed legislation, and other policy statements or actions that have substantial direct effects on one or more Native American tribes; on the relationship between the Federal Government and Native American tribes; or on the distribution of power and responsibilities between the Federal Government and Native American tribes.

Native American tribes have held treaty rights for fishing and hunting since the early 1800s. Treaty fishing rights pertain to finfish, shellfish, and in some instances, marine mammals (whales and seals) (http://sanctuaries.nos.noaa.gov, accessed in January 2003). These rights are part of the Native American, Alaskan, and Hawaiian people's traditional culture, livelihood, and subsistence. Subsistence fishing and hunting is a way of life that includes historical practices and can be the cultural "glue" that holds a Tribe together (http://lib.cmich.edu/clarke/treatyfishing.htm, accessed in January 2003).

Many tribes have organized fishery management systems allowing them sizable subsistence and small commercial catches. Fish stocks and water quality are linked to the health of an ecosystem and to the activities that occur in the watershed. As discussed throughout this PEA, NIS can impact various commercial and recreational fish species and water quality; and consequently can impact watershed systems causing disruptions to the food web. As a result, NIS can impact Native American fisheries and, in turn, the tribes' subsistence.

- In the Great Lakes region, the once abundant *Diporeia* is now non-existent in Lakes Michigan and Huron, and is rapidly declining in other areas due to zebra mussel invasion. *Diporeia* is an essential food for whitefish and other major species, and is essentially a key link in the Great Lakes food web. Its decline threatens to produce a sharp decline in related fisheries, perhaps resulting in an ecological disaster. This decline affects the fisheries of the Chippewa Indians of the Great Lakes region. The Sault Ste. Marie Tribe of Chippewa Indians testified to the U.S. Senate Committee on Indian Affairs in support of the Great Lake Ecology Protection Act to assure that vessels entering the Great Lakes do not discharge ballast water that could introduce or spread aquatic NIS, and that ballast water and its associated sediments are treated through the most effective and efficient technologies available, now and in the future (U.S. Senate Committee on Indian Affairs 2001).
- In Alaska, salmon is a renewable resource worth millions of dollars to commercial interests, sport fisheries, personal use, Native Alaskan subsistence, and fishing economies. Historically, the enormous number of native salmon played an important role in defining the entire Pacific Northwest and Alaska's unique character and economy. Today, many of the great runs of Pacific salmon are depressed and depleted to the point of being listed by NMFS as a threatened and endangered species (Alaska Department of Fish and Game 2002). In the early 1980s, British Columbia and Washington began the use of net-pen culturing facilities to raise salmon. Although five Pacific salmon species are endemic to this region, salmon farmers turned to exotic Atlantic salmon because they are easier to culture in net pens. Due to accidental spills or weather-related damage to the rearing facilities, some of these fish have escaped into marine waters of western Pacific Coast and occurrences of the Atlantic salmon have been found in commercial fisheries in Alaskan waters (Brodeur and Busby 1998). In 1990, the farming of finfish in Alaska was banned to protect wild stocks from the danger of disease and pollution, as well as the possibility of escaped farm fish breeding with wild fish (Alaska Department of Fish and Game 2002). The Atlantic salmon poses a serious threat to the wild Pacific salmon and the Pacific Coast ecosystem (Brodeur and Busby 1998). Introductions of non-native species have frequently resulted in unexpected, and often catastrophic, consequences from habitat destruction, disease, parasites,

hybridization, reproductive proliferation, predation and competition (Alaska Department of Fish and Game 2002).

- The Olympic Coast National Marine Sanctuary strives to maintain a balance among a variety of natural resource management issues in the sanctuary. Some of the issues involve Native American tribe treaty rights, land-based and vessel discharge sources of pollution, and the introduction of NIS via ballast water discharge. Native American tribes are taking an active role as partners with the Sanctuary and State environmental agencies to research, educate and develop management decisions to reduce NIS introductions, and protect their fisheries and the Sanctuary's natural resources.

3.3.1.4 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. The Presidential Memorandum that accompanied the Executive Order recognizes the importance of procedures under NEPA to identify and address environmental justice concerns. The memorandum states "each Federal agency shall analyze the environmental effects, including human health, economic and social effects, of Federal actions, including effects on minority and low-income communities, when such analysis is required by NEPA."

The process to identify disproportionate impacts associated with the Proposed Action and to ensure compliance with this directive involves:

- Identification of the potentially affected population;
- Characterization of the study area with respect to minorities and low income populations;
- Determination of potentially significant adverse impacts of the proposed action and alternatives; and,
- Evaluation of the potential for disproportionately high and adverse impacts on minority and low-income populations.

3.3.2 Costs of Mandatory Ballast Water Management

The cost of mandatory BWM will be discussed in detail in the associated Economic Impact Analysis currently being developed by the U.S. Coast Guard. The Coast Guard estimates that the proposed rule will cost the shipping industry approximately $15.8 million annually. These costs are not quantified in this PEA. In general, ballast water exchange will cause the shipping industry to incur additional expenses related to ballast water pump operations (e.g., fuel, wear and tear). One study estimated the cost of mid-ocean exchange at approximately $0.02 to $0.10 per metric ton (URS/Dames and Moore 2000). The management practice to retain ballast water onboard the vessel may have potential impact to the industry as it may limit the amount of cargo that a vessel could load. The use of an alternative environmentally sound method of BWM approved by the U.S. Coast Guard would have specific associated costs to be borne by the shipping company choosing to install a ballast water treatment system. One study determined a rough order of magnitude estimate of "$1000s to $100,000s per vessel" for such systems (Carlton *et al.* 1992). A second study estimated that an onboard filtration system, just one example of onboard treatment methodology, could cost approximately $200,000 to design, build, and install, and $250,000 annually to operate (USEPA 2001). Yet another source stated that the installation of a microfiltration system on a new vessel would cost approximately $1.6 million (http://navyseic.dt.navy.mil/hot.htm, accessed in January 2003). Costs associated with the discharge of ballast water to an approved reception facility include: the cost to construct, operate, and maintain the shoreside reception facility, the cost to the shipping industry to pump ballast water to the facility, and potentially, to utilize the facilities' ballast water treatment/holding services. As an example, the cost to construct the Alyeska Ballast Water Treatment Facility at the Valdez Marine Terminal in Alaska was $1.4 billion; the facility covers 1,000 acres of land (USEPA 2001).

3.3.3 Shipping Safety

Safety is a concern that has been consistently raised for mid-ocean ballast water exchange. As ballast water is removed from vessels, maneuverability and stability may be compromised. Any reduction in ballast water levels may result in sloshing within the tanks, affecting vessel stability (Hay and Tanis 1998). In addition, movement of ballast water within a vessel can impose shear stresses and bending moments, which may compromise structural integrity (Hayes and Hewitt 1999). While complete deballasting/reballasting is viewed as the more effective method of ballast water exchange, dilution/flushing methods generally tend to be safer. This method, however, poses several individual safety concerns, as malfunctions during the dilution process could result in over-pressurization of ballast tanks resulting in weakening or splitting hull welds. To avoid this risk, tank lids or manhole covers may be removed, but this technique may present other safety issues for the crew and vessel (Hay and Tanis 1998).

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Biological Environment, including Threatened and Endangered Species and Essential Fish Habitat

Under the No Action Alternative voluntary BWM guidelines would remain in effect, however, it is expected that the number of vessels implementing these practices would remain as low as currently experienced, except for the Great Lakes and Hudson River where mandatory BWM is required. As a result NIS from most phyla and taxonomic groups would continue to be released through ballast water discharges and establish themselves in U.S. waters at present or increasing rates. This would continue to adversely impact the biological environment (described in Section 3.1). Direct and indirect adverse impacts on threatened, endangered, or protected species, such as marine mammals and sea turtles, as well as EFH would continue. For example, in a comprehensive review of introduced mollusks, it was stated that based on recent introductions it can be strongly argued that, "ballast-water mediated invasions would continue to be a regular phenomenon in North America" (Carlton 1992). While not all introductions result in dramatic impacts, the establishment of any new species in an ecosystem would have some impact on biological systems and biodiversity (Carlton 1999a).

Implementation of the Proposed Action is expected to increase the number of vessels applying BWM guidelines. Use of any of the proposed BWM practices would be expected to reduce the number of introduced microorganisms as compared to the No Action Alternative.

- Mid-ocean exchange of ballast water has been shown to be approximately 50 to 90 percent effective at removing microorganisms from ballast water (USCG 2001). However, studies are lacking on the effectiveness of BWE on nonindigenous fish, invertebrates, and submerged and emergent plants.

- Retention of ballast water onboard would prevent any discharge of NIS from ships entering U.S. waters after operating outside of the EEZ.

- Discharge to an approved reception facility would, depending on the level of subsequent treatment, either prevent or considerably decrease the level of introduction of NIS from ships entering U.S. waters after operating outside of the EEZ.

- Although other "environmentally sound" methods have not yet been fully assessed, it is assumed that by definition, only methods that achieve substantial reduction in NIS releases from ships entering U.S. waters after operating outside of the EEZ would be approved.

As a result, the Proposed Action would be expected to reduce the number of nonindigenous microorganisms discharged into U.S. waters via ballast water from ships entering U.S. waters after operating outside of the EEZ. The pressure from NIS introduced via ballast water on threatened, endangered, or protected species, such as marine mammals and sea turtles, as well as EFH is likely to be reduced. This is likely to be a potential beneficial impact to the biological environment over the current conditions.

Also under the Proposed Action the impacts from the mid-ocean ballast water exchange to endangered marine mammals and sea turtles would likely be reduced if, for example, the exchanges process took place away from areas known for feeding or breeding for these species such as warm-ring cores at the ocean surface and the Sargasso Sea region.

4.2 Physical and Chemical Environment

Information regarding the direct impact of ballast water discharge on the physical and chemical environment of receiving waters is extremely limited. Any discussion of potential impacts must be based on a theoretical assessment of the physical and chemical components of ballast water and the typical receiving environments of U.S. waters.

Foreign and U.S. ports cover a broad range of salinities and temperatures from tropical freshwater lakes and rivers, to brackish estuaries, to temperate marine ports. Under the No Action Alternative, there could be considerable variation, on a case-by-case basis, in the salinities or temperatures of the discharged and receiving waters. Because of the broad potential variations between ballast water discharges and receiving waters, it is impossible to determine or even speculate what affects could result to the salinities and temperatures of receiving waters. When ballast water discharges are of similar salinity or temperature to the receiving waters, minimal impact would be expected. When the discharged ballast water is of greatly different salinity or temperature than the receiving waters, there would be the potential for a temporary adverse impact on organisms in the immediate discharge area of the receiving waters that would dissipate as the discharged ballast waters become diluted.

Pollutants from local industries, communities, and various non-point sources affect the water in ports and harbors worldwide. Ballast water discharged from ships entering U.S. waters after operating outside of the EEZ may contain a broad range of nutrients and toxic substances, as well as various amounts of entrained sediments. The discharge of ballast of water may also stir up natural sediments at the point of discharge creating localized levels of elevated turbidity. Under the No Action Alternative, these discharges would continue at present or increasing levels, with likely continued adverse impacts.

Each of the four components of the Proposed Action would have differing potential impacts on the physical and chemical environment of both the mid-ocean and the receiving waters in the U.S. The following paragraphs summarize these potential impacts.

- Under the ballast water exchange practice of the Proposed Action, mid-ocean water (i.e., high salinity) would be discharged into U.S. waters. Again, the wide range of salinity and temperature conditions across U.S. ports makes it impossible to determine or even speculate what affects could result. However, the discharge of ballast water may stir up natural sediments at the point of discharge, creating localized levels of elevated turbidity. Little other impact would be expected to the physical and chemical properties of the receiving waters, since the discharge of mid-ocean waters would contain low levels of nutrients and toxic substances. Nevertheless, when discharging these mid-ocean waters to freshwater ports, there may be potential for impacts to organisms in the immediate discharge area.

- Retention of ballast water onboard from ships entering U.S. waters after operating outside of the EEZ would prevent any discharges of water of different salinities and temperatures or water containing nutrients or toxic substances or entrained sediments.

- Discharge of ballast water from ships entering U.S. waters after operating outside of the EEZ to an approved reception facility would, depending on the level of subsequent treatment, either prevent or considerably decrease the discharge of water of different salinities and temperatures or water containing nutrients or toxic substances or entrained sediments.

- Although other "environmentally sound" methods have not yet been fully assessed, it is assumed that by definition, only methods that would reduce the effect of salinity, temperature, and entrained nutrients and toxic substances in ballast water discharges would be approved.

As a result, impacts associated with salinity, temperature, and entrained nutrients, toxic substances, and sediments in discharged ballast water would likely be reduced, resulting in a potential beneficial impact over current conditions.

4.3 Socioeconomic

4.3.1 Socioeconomic Impacts of NIS Introductions via Ballast Water

Under the No Action Alternative, costs of control and management efforts for NIS from ballast water discharges from ships entering U.S. waters after operating outside of the EEZ added to the management of water-dependent infrastructure would continue at present or increasing levels. In addition, there are NIS related economic effects from lost income due to reductions in commercial and recreational fishing and water-dependent tourism. These NIS related effects would continue to cause adverse socioeconomic impacts.

With increased BWM under the Proposed Action, reduced levels of NIS from ballast water discharges from ships entering U.S. waters after operating outside of the EEZ would likely have a potential beneficial economic impact (including impacts to water-dependent infrastructure, fisheries and water-dependent tourism, and required control and management efforts). Given that significant introductions of NIS have already occurred, it is difficult to quantify the benefits of further prevention.

4.3.2 Risks to Human Health

Under the No Action Alternative, the potential for increased human health risks from the introduction of new pathogenic organisms via ballast water discharges from ships entering U.S. waters from foreign ports would continue to exist. With increased BWM under the Proposed Action, there is expected to be a reduced level of new pathogenic organisms introduced from ballast water discharges from ships entering U.S. waters after operating outside of the EEZ. The Proposed Action would likely pose less future risk to human health.

4.3.3 Environmental Justice and Tribal Fishing Rights

Under the No Action Alternative, the potential would continue for minority and low-income populations and Native Americans who rely on fishing for their subsistence to be adversely impacted by NIS. This NIS related threat could exist if fish stocks are adversely affected or new NIS related human health risks are found.

Under the Proposed Action, the potential for mandated BWM guidelines to reduce NIS introductions would likely occur. Lower levels of NIS introductions would likely reduce the threat to minority and low-income populations and Native Americans.

Under both the No Action Alternative and the Proposed Action Alternative, there are no tribal implications under Executive Order 13175. Under each alternative, the action would not have a substantial direct effect on one or more Native American tribes, on the relationship between the Federal

Government and Native American tribes, or on the distribution of power and responsibilities between the Federal Government and Native American tribes.

4.3.4 Costs of Mandatory Ballast Water Management Program

Costs for BWM to the shipping industry would have the potential to be incrementally greater under the Proposed Action than under the No Action Alternative. Under the No Action Alternative, BWM guidelines are voluntary, except for vessels entering the Great Lakes and the Hudson River. Evidence indicates that a small percentage of vessels comply with these voluntary measures, thus minimal costs are incurred. With mandatory BWM program, the shipping industry would likely incur greater costs to comply.

4.3.5 Shipping Safety

Both the No Action Alternative and the Proposed Action Alternative specify that vessels are exempt from the ballast water exchange component of the BWM guidelines, if safety concerns exist. In such cases, a vessel entering U.S. waters from a foreign port may only discharge the amount of ballast water operationally necessary (BWM would have to occur, however, prior to entering the Great Lakes or Hudson River), and, upon request, the vessel captain would be required to furnish documentation supporting safety concerns. The ultimate decision to conduct BWM, including mid-ocean ballast water exchange, rests with the ship's master when safety concerns exist, thereby removing the potential for shipping safety risks associated with the Proposed Action. The inclusion of this safety exemption under either alternative would have the potential for only minimal impacts in shipping safety.

4.4 Conclusion

Under the No Action alternative the opportunity for the introduction of NIS to U.S. waters will increase due to the growth of the global economy. Since vessels are the primary mode of transportation of foreign goods into the U.S., continued growth of the global economy will result in increasing numbers of vessels arriving at U.S. ports from foreign ports. In addition, continued improvements to vessel technology are expected to result in further reduction in vessel transit times. Studies have shown that shorter transit times result in improved survival rates of NIS in ballast water due to the reduced retention time in the ballast water.

Recognizing that the survival rates of NIS are likely to improve, the Secretary's Report to Congress recommended that the highest possible rate of compliance should be sought since anything less than 100 percent compliance would facilitate the continued release of NIS to U.S. waters (USCG 2001). With increasing survival rates of NIS, the probability for the introduction of another extremely harmful or costly NIS to U.S. waters (like the zebra mussel) becomes more likely. The Proposed Action for mandated ballast water management for vessels entering U.S. waters after operating outside of the EEZ (See 33 CFR Part 151 Subpart D) includes a program of four components (Section 2.1.2). The component of mandatory mid-ocean ballast water exchange is expected to be approximately 50 to 90 percent effective at removing microorganisms from ballast water, with some additional, yet unstudied, effect on the full range of biological organisms. Mandatory retention of ballast water onboard, for vessels of appropriate design, would prevent any discharge of NIS from ships entering U.S. waters from foreign ports. Discharge of ballast water to an approved reception facility would, depending on the level of subsequent treatment, either prevent or considerably decrease the level of introduction of NIS from ships entering U.S. waters after operating outside of the EEZ. Other "environmentally sound" methods to treat ballast water are expected to achieve substantial reductions in NIS releases from ships entering U.S.

waters after operating outside of the EEZ. These four components are intended to achieve a substantial level of prevention and control of further introduction of NIS from ballast water from vessels entering U.S. waters from foreign ports. Table 2 contains a summary of these effects. While the Proposed Action cannot guarantee 100 percent effectiveness, the overall potential beneficial impacts of mandated BWM guidelines outweigh the continuation of voluntary BWM practices, and would move towards achieving the 100 percent effectiveness goal.

While Mandatory ballast water exchange clearly has a positive benefit to the environment, it is by no means clear that it is 100% effective. Few vessels, in the foreseeable future, will be able to fully retain their ballast water onboard. Due to cost restraints, large numbers of onshore reception facilities are not likely to be available to treat ballast water. "Environmentally sound" alternative ballast water treatment methods are not currently approved and are not likely to be approved for several years in the future. Because of the broad potential variations between NIS in the ballast water discharges and their likelihood of survival in the receiving waters, it is not possible to determine to what extent any remaining organisms entering the U.S. in ballast waters from foreign ports under the Proposed Action would become permanently established. Therefore the potential for an introduction of another extremely harmful or costly NIS remains. Thus, while the Proposed Action would provide a higher level of prevention and control of NIS than No Action, it is not clear whether the remaining risk of introduction of NIS under the Proposed Action would have significantly less impact on the human environment. Thus, we cannot say that the clearly positive benefit will be significant.

TABLE 2. SUMMARY OF ENVIRONMENT IMPACTS

Affected Environment	***No Action Alternative*** (Existing Conditions)	***Proposed Action Alternative*** (Alternative Conditions)
Biological Environment		
Biological Systems	Adverse Impact	Potential Beneficial Impact
Microbes/Plankton	Adverse Impact	Potential Beneficial Impact
Invertebrates	Adverse Impact	Potential Beneficial Impact
Fishes	Adverse Impact	Potential Beneficial Impact
Submerged/Emergent Plants	Adverse Impact	Potential Beneficial Impact
T & E Species	Adverse Impact	Potential Beneficial Impact
Essential Fish Habitats	Adverse Impact	Potential Beneficial Impact
Physical/Chemical Environment		
Salinity		
Marine to Freshwater	Potential Adverse Impact to Organisms	Potential Adverse Impact to Organisms
Freshwater to Marine	Potential Adverse Impact to Organisms	Potential Minimal Impact
Similar Salinity	Potential Minimal Impact	Potential Minimal Impact
Temperature	Potential Adverse Impact to Organisms	Potential Adverse Impact to Organisms
Turbidity	Potential Adverse Impact to Organisms	Potential Beneficial Impact
Nutrients	Potential Adverse Impact	Potential Beneficial Impact
Toxic Substances	Potential Adverse Impact	Potential Beneficial Impact
Socioeconomic Environment		
Economic Systems		
Water-Dependent Infrastructure	Adverse Impact	Potential Beneficial Impact
Water-Dependent Tourism and Fisheries	Adverse Impact	Potential Beneficial Impact
Control and Management	Adverse Impact	Potential Beneficial Impact
Risks to Public Health	Likely Increasing Risk	Potential Beneficial Impact
Environmental Justice and Tribal Fishing Rights	Potential Adverse Impact	Potential Beneficial Impact
Costs of Mandatory Ballast Management Program	No additional cost	Increased costs to vessel owners
Shipping Safety	No Impact	Minimal Impact

5.0 IDENTIFIED ENVIRONMENTAL, REVIEW AND CONSULTATION REQUIREMENT

5.1 Endangered Species Act of 1973

Endangered and threatened species are protected at the Federal level under the ESA of 1973 (87 § 884, as amended; 16 USC 1531 *et seq.*). The purpose of the ESA is to ensure Federal agencies make all attempts to conserve endangered and threatened species and their habitats. The USFWS and NMFS are the responsible administrative authorities of the ESA. The USFWS is primarily responsible for terrestrial and freshwater species, and migratory birds, while the NMFS generally deals with those species occurring in marine environments and anadromous fish. Anadromous fish are species that spend most of their life in marine environments, but migrate into freshwater rivers to spawn.

All Federal agencies must consult with the USFWS and NMFS, in accordance with Section 7 of the ESA, to ensure that their actions are not likely to jeopardize the continued existence of listed species. The U.S. Coast Guard has initiated informal consultation with the USFWS and the NMFS to determine if any endangered or threatened species (Appendix B) could be affected by the Proposed Action.

5.2 Coastal Zone Management Act of 1972

The Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C.A. §1451-1465) was passed by Congress to effectively manage the uses and resources of the Nation's coastal zone. The enactment of the CZMA resulted from a range of Congressional findings involving the preservation, protection, development, restoration and enhancement of resources of the U.S. coastal zone. The following are just three of the Congressional findings that directly relate and serve as supporting needs for the Proposed Action:

"1) The increasing and competing demands upon the lands of our coastal zone occasioned by population growth and economic development, including requirements for industry, commerce, residential development, recreation, extractions of mineral resources and fossil fuels, transportation and navigation, waste disposal, and harvesting of fish, shellfish, and other living marine resources, have resulted in the loss of living marine resources, wildlife, nutrient rich areas, permanent and adverse changes to ecological systems, decreasing open space for public use, and shoreline erosion.

2) The habitat areas of the coastal zone, and the fish, shellfish, other living marine resources, and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alternations.

3) New and expanding demands for food, energy, minerals, defense needs, recreation, waste disposal, transportation, and industrial activities in the Great Lakes, territorial sea, and exclusive economic zone, and the Outer Continental Shelf are placing stress on these areas and are creating the need for resolutions of serious conflicts among important and competing uses and values in coastal and ocean waters." (CZMA, Section 302)

In accordance with the CZMA, each Federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall be carried out in a manner that is consistent, to the maximum extent practical, with the enforceable policies of the approved State coastal zone management programs. Additionally, each Federal agency carrying out such an activity shall provide a Federal consistency determination to the relevant State agency (Appendix C) and shall undertake the activity, to the maximum extent practicable, consistent with the enforceable policies of approved state coastal zone management programs (§1456, Section 307).

As mandated in NISA, the Proposed Action would result in a mandatory BWM program for all vessels entering U.S. waters after operating outside of the EEZ, thereby potentially affecting the Nation's coastal zone. Therefore, in compliance with the requirements of CZMA, the U.S. Coast Guard is in the process of coordinating with State Coastal Zone Management Program (CZMP) contacts, reviewing state plans, and preparing federal consistency determination letters for State and U.S. Territorial approval. States and U.S. Territories with CZMPs include Alabama, Alaska, California, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois*, Indiana, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Virginia, Washington, Wisconsin, American Samoa, Guam, Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands (State denoted with an * has an inactive Federally-approved CZMP).

5.3 Programmatic Biological Assessment

The Endangered Species Act (ESA) of 1973 was passed by the United States Congress to provide a means to conserve ecosystems and the endangered and threatened species that depend upon them. All Federal agencies must (1) seek to conserve endangered and threatened species and (2) utilize their authorities to further the purposes of the ESA. Section 7(a)(2) of the ESA requires Federal agencies to ensure that any action authorized, funded, or carried out by that agency is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of habitat of such species which has been designated as critical habitat. To ensure such actions are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat, these federal agencies must consult with U.S. Fish & Wildlife Service and National Marine Fisheries Service, who administer the ESA. The tool used by the Services to analyze impacts to listed species is the Biological Assessment (BA) and their decision is documented in a Biological Opinion (BO).

In keeping with Council of Environmental Quality (CEQ) National Environmental Policy Act (NEPA) Regulation 40 CFR 1502.25 (a) and (b) to integrate other federal environment laws into the NEPA process, the Affect Environment and Environmental Consequences sections in this Programmatic Environmental Assessment serves to meet the ESA informal Section 7 consultation requirements for US Fish & Wildlife Service and National Marine Fisheries Service's Programmatic Biological Assessment for this proposed rule - a Federal action.

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7.0 GLOSSARY OF ACRONYMS

APHIS	U.S. Department of Agriculture Animal and Plant Health Inspection Service
BWM	Ballast Water Management
CAPA	California Association of Port Authorities
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
COTP	Captain of the Port
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Program
DOD	U.S. Department of Defense
DOJ	U.S. Department of Justice
DOT	U.S. Department of Transportation
DOS	U.S. Department of State
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ERE	Empty Refill Exchange
ESA	Endangered Species Act
FDA	U.S. Food and Drug Administration
FONSI	Finding of No Significant Impact
FR	Federal Register
FTE	Flow Through Exchange
GAO	United States General Accounting Office
GMRP	Gulf of Mexico Regional Panel
HAB	Harmful Algal Bloom
IMO	International Maritime Organization (United Nations)
MARAD	U.S. Maritime Administration
MMPA	Marine Mammal Protection Act
NANPCA	Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990
NEPA	National Environmental Policy Act of 1996
NIS	Nonindigenous Species
NISA	National Invasive Species Act of 1996
NMFS	National Marine Fisheries Service (U.S.)
NOAA	National Oceanic and Atmospheric Administration
NOBOB	No Ballast on Board
NPDES	National Pollutant Discharge Elimination System
OOCL	Orient Overseas Container Line
PEA	Programmatic Environmental Assessment
POTW	Publicly-Owned treatment works

SFDD	San Francisco Dry Dock
SFA	Sustainable Fisheries Act
U.S.	United States
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UV	Ultraviolet

8.0 GLOSSARY OF DEFINITIONS

Exclusive Economic Zone (EEZ) refers the area established by Presidential Proclamation Number 5030, dated 10, 1983 (48 FR 10605, 3 CFR, 1983 Comp., p.22), which extends from the base line of the territorial sea of the United States seaward 200 miles, and the equivalent zone of Canada.

IMO ballast water control guidelines refers to the International Maritime Organization's Guidelines for the Control and Management of Ship's Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens (IMO Resolution A.868 (20), adopted November 1997).

Nonindigenous species (NIS) refers to an organism (or group of organisms) present outside of its native or historical range. When a NIS is transported outside of its native range by human activities, for example, in ballast water, it is considered to be an *introduced* species. Once a NIS has been introduced to a new area it must survive the environmental and ecological conditions of that new ecosystem before it can become established. Only when a species is successfully reproducing in an area is it considered *established*. Once a species has become established, it may then become invasive in the new ecosystem. An *invasive species* (or *bioinvader*) is a NIS that causes some measure of ecological harm to the new ecosystem, typically by expanding its range or concentration to the detriment of native species and habitats. This *bioinvasion* can disrupt native populations and ecosystems. The impacts of an invasive species may ultimately make them a nuisance species, or more specifically in the present discussion, an aquatic nuisance species. The term *nuisance species* is a subjective description based on a species' impact on human activities and values. These include economic, recreational, health, and aesthetic impacts. Predicting the ultimate impact a NIS will have on a given area is virtually impossible. It can be an equally difficult task to control or manage the impacts of a NIS once they have been introduced. Therefore the ultimate goal of the Proposed Action is to prevent NIS introductions.

United States refers to the 50 States, the District of Columbia, the Commonwealth of Puerto Rico, Guam, American Samoa, the U.S. Virgin Islands, and the Trust Territory of the Pacific Islands.

Voyage refers to any transit by a vessel destined for any U.S. port from a port of place outside of the EEZ, including intermediate stops at a port of place within the EEZ. For the purpose of this rule, a transit by a vessel from a U.S. port to any other U.S. port, if at any time the vessel operates outside the EEZ or equivalent zone of Canada, is also considered a voyage.

Waters in the present discussion centers on the transport of NIS from foreign ports to U.S. ports in the ballast tanks of vessels. The content of ballast tanks can include both water and sediment. For this discussion these two media are combined into the general term "waters." Some distinctions between the types of waters involved include:

- **Source water** refers to water taken up during ballasting at a foreign (non-U.S.) port. Because of the diversity of ports around the world, the physical, chemical, and biological properties of source water will vary widely. This water may be from river, lake, estuary, marine, or other aquatic environments. In addition, source water may be comprised of waters from many foreign ports.
- **Ballast water** is the water contained in the ballast tanks of a vessel. Ballast water is taken up or discharged to control vessel functions.
- **Mid-ocean water** is open ocean water at least 200 miles from any shore.

- **Receiving waters** are U.S. waters into which ballast water is discharged. These may be river, lake, estuarine, marine or other waters. Receiving waters includes any and all waters inside the U.S. EEZ.

9.0 LIST OF PREPARERS

	Name	Title	Professional Experience	Education	Project Responsibility
Environmental Protection Agency					
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	Name	Title	Professional Experience	Education	Project Responsibility
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10.0 AGENCIES AND PERSONS CONSULTED

Section 1101 (d) of NISA directs the Secretary of Transportation to prepare and submit a Report to Congress – not sooner than 24 months after the date of issuance of guidelines and not later than 30 months after such date; and after consultation with interested and affected persons – containing information on the rate of compliance and the effectiveness of voluntary BWM guidelines. In November 2001, the Report to Congress on the Voluntary National Guidelines for Ballast Water Management was submitted. On June 3, 2002, the Secretary submitted a letter to the President and the Speaker of the House of Representatives stating regulatory documentation will be ready for U.S. Department of Transportation (DOT) and Inter-Departmental review on (1) transitioning from a voluntary national BWM program to a mandatory program: Notice of Proposed Rulemaking (NPRM) in the Fall of 2003; and (2) the Final Rule in Summer of 2004 (DOT 2002).

The preparation of this PEA is in response to the regulatory documentation commitment. In accordance with NISA and NEPA, coordination and consultation with Federal and State agencies and interested parties and individuals is required to advance the Proposed Action. In response, the EPA and USCG have initial informal coordination with the USFWS, NMFS, and State CZMP contacts.

Appendix A

Representative NIS and Case Studies

REPRESENTATIVE NIS AND CASE STUDIES

Table A-1 presents a selection of NIS thought to have been introduced to U.S. waters via ballast water discharge. The selection of species represents introductions to all regions of the U.S., and the table identifies confirmed impacts related to bioinvasions by these species. Four detailed case studies follow.

1 – Zebra Mussels in the Great Lakes

Figure A-1. Zebra mussel (Courtesy of www.serconline. org/ballast /fact.html)

In the late 1980s, the dramatic impacts of bioinvasions by NIS were brought to the U.S. public's attention. The zebra mussel (*Dreissena polymorpha*) (Figure A-1), a native of the Caspian Sea, was introduced to the Great Lakes via ballast water from a Russian freighter. As the species quickly took hold and spread through the region, biological and physical impacts were widespread, and economic distress soon followed. Fouling by zebra mussels has disrupted, or even shut down, hydropower facilities, locks and dams, municipal water supplies, and other water intake and control structures (http://www.anstaskforce.gov, accessed in January 2003). The widespread impacts of the zebra mussel were a major impetus for the passage of the NANPCA of 1990 (http://www.anstaskforce.gov, accessed in January 2003).

The biofouling capacity of zebra mussels has been the primary source of their economic impacts. The mussel colonizes water supply pipes of power plants, drinking water plants, and other industrial facilities. Densities of zebra mussels in these pipes have reached up to 700,000 m^2, and thicknesses greater than 0.3 meters (http://nas.er.usgs.gov/zebra.mussel/docs/sp_account.html, accessed in January 2003, Mangin 2001). Even a layer only 1 to 2 millimeters in thickness can reduce pipeline water carrying capacity by 5 to 10 percent, restricting flow for heat exchangers, condensers, fire fighting equipment, and air conditioning and cooling systems. Water-treatment facilities have reported that zebra mussels have clogged pipes, reducing the inside diameter by up to two-thirds (http://nas.er.usgs.gov/zebra.mussel/docs/sp_account.html, accessed in January 2003). Other systems are also at risk for zebra mussel fouling. Boats hulls and engines are susceptible to fouling, reducing performance. Fishing gear, pilings, buoys, research equipment, and anything else left in the water for extended periods may by deteriorated by zebra mussel encrustation.

The rapid spread of zebra mussels indicates that direct competition with native mussels may have a serious impact. Zebra mussels also directly impact native mussels by growing on and over them reducing their ability to feed. Other ecological impacts may be more complex. The high densities of zebra mussels filter enormous volumes of Great Lakes water each day. This has resulted in increased light penetration through the water column. The potential consequences of this are diverse. Increased water clarity has resulted in the return of many aquatic plant species whose densities had been reduced by pollution in the lakes, and these plant species function as nurseries for some fish species. On the other hand, the high filtration rates have reduced some phytoplankton concentrations by up to 80 percent (Mangin 2001), which may disrupt the very food webs fish depend on. The long-term effects of these processes are yet to be realized.

Ballast water has been implicated as the most probable vector for the initial introduction of the zebra mussel to the U.S. Individual zebra mussels may be able to survive in ballast tanks for many days to weeks in either the larval or juvenile stages (Carlton 1993). However, since this species may also be easily transported by a variety of mechanisms, including natural processes, dispersal through pipes, hull fouling of commercial and recreational vessels, fisheries operations, aquariums, fire trucks, amphibious planes, and transport of commercial goods, it may be expected that zebra mussels would continue to spread through U.S. waterways (Carlton 1993). As shown in Figure A-2, Zebra mussels have spread rapidly since their first detection in 1988. By 1990, they were found in all of the Great Lakes and by 2002 at least 21 states reported the presence of zebra mussels (http://nas.er.usgs.gov/zebra.mussel/docs/sp_account.html, accessed in January 2003).

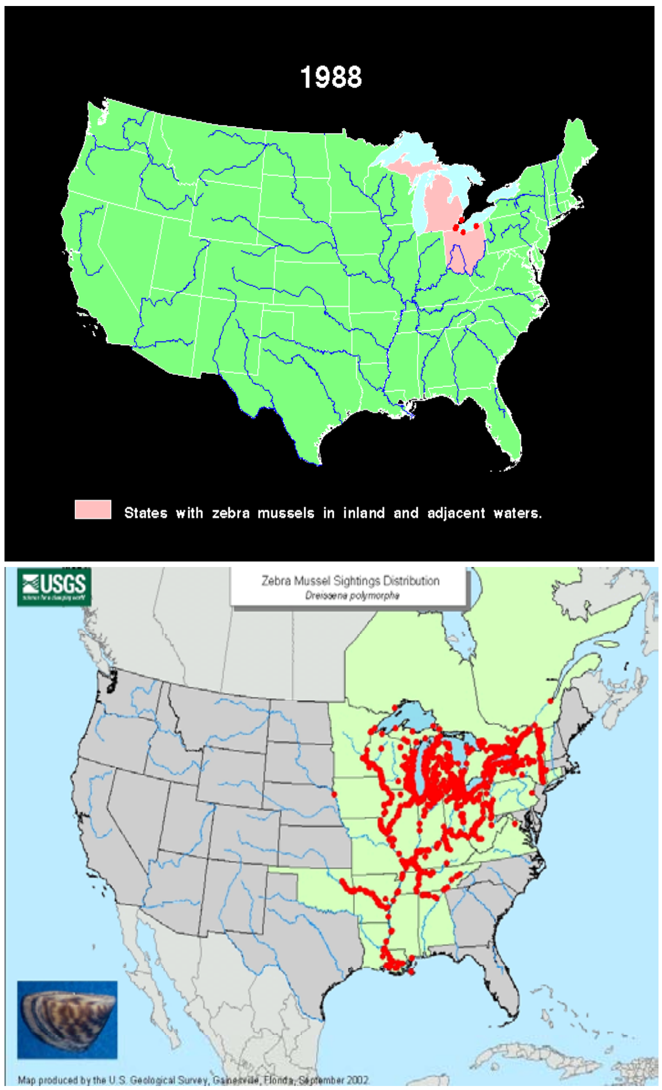

Figure A-2. Confirmed distribution of zebra mussels in U.S. waters in 1988 and September 2002 (Courtesy of USGS Biological Resources Division).

Table A-1. Representative Aquatic NIS and Associated Environmental Impacts

Scientific Name / Common Name	Organism Type	U.S. Region in which Found	Ecological Impacts	Human Health Impacts	Economic Impacts	Recreational Impacts	Unknown Impacts
Rapana venosa veined rapa welk	Mollusk	East Coast	√		√		
Loxothlacus panopaei rhizocephalan barnacle	Barnacle	East Coast	√				
Membranipora membranacea European bryozoan	Moss Animal	East Coast	√				√
Ascidiella aspersa European seasquirt	Tunicate	East Coast					√
Blackfordia virginica Black Sea jellyfish	Jellyfish	East Coast / West Coast					√
Cotula coronopifolia brass buttons	Vascular Plant	East Coast / West Coast					√
Carcinus maenas European green crab	Crab	East Coast / West Coast / high potential for Alaska	√		√		√
Dreissena polymorpha Eurasian zebra mussel	Mollusk	East Coast / Great Lakes / Hudson River / Gulf of Mexico	√		√	√	
Hemirapsus sanguineus Japanese shore crab	Crab	East Coast / West Coast / Gulf of Mexico	√				√
Callichrous bimaculatus fourspine stickle back	Fish	Great Lakes / Hudson River	√				√
Gymnocephalus cernuus European ruffe	Fish	Great Lakes / Hudson River	√		√	√	
Proterorhinus marmoratus tubenose goby	Fish	Great Lakes / Hudson River	√				√
Proterorhinus marmoratus Black Sea goby	Fish	Great Lakes / Hudson River					√
Pomatoschistus marmoratus Mediterranean goby	Fish	Great Lakes / Hudson River					√
Dreissena bugensis quagga mussel	Mollusk	Great Lakes / Hudson River					√

Scientific Name / Common Name	Organism Type	U.S. Region in which Found	Ecological Impacts	Human Health Impacts	Economic Impacts	Recreational Impacts	Unknown Impacts
Neogobius melanostomus round goby	Fish	Great Lakes / Hudson River	√	√		√	
Trochammina hadai	Foraminfera	Alaska					√
Eriocheir sinensis Chinese mitten crab	Crab	West Coast	√	√	√		
Polysiphonia denudate red siphonweed	Seaweed	West Coast					√
Caulerpa taxifolia killer algae	Alga	West Coast	√		√		
Acanthogobius flavimanus yellowfin goby	Fish	West Coast					√
Tridentiger bifasciatus shimofuri goby	Fish	West Coast	√				√
Tridentiger trigonocephalus chameleon goby	Fish	West Coast					√
Potamocorbula amurensis Asian clam	Mollusk	West Coast	√	√	√		
Mugiligobius parvus Philippine goby	Fish	Hawaii					√
Vibrio cholerae South American cholera	Pathogen	Gulf of Mexico		√			√
Perna perna South American brown mussel	Mollusk	Gulf of Mexico	√		√		√
Pistia stratiotes waterlettuce	Plant	* East Coast / West Coat / Hawaii / Puerto Rico / Virgin Islands	√			√	
No organisms found		American Samoa					
No organisms found		Guam					

* All locations may not be associated with introduction via ballast water discharge.

2 – Chinese Mitten Crabs in California

Figure A-3. Chinese mitten crab (Courtesy of California Department of Fish and Game)

The Chinese mitten crab (*Eriocheir sinensis*) (Figure A-3) was first identified in San Francisco Bay, California, in 1992. The most likely mechanism for transport and introduction of this species was either intentional release or via ballast water (Cohen and Carlton 1997). By 1998, over one million mitten crabs were collected from the Bay (Veldhuizen and Stanish 1999). The ecological and economic threats that this species poses in U.S. waters are still relatively unknown. Much of the information regarding the Chinese mitten crab as a bioinvader comes from invasions in Europe and China.

The foremost concern for mitten crab presence is their burrowing capacity and its potential impact on erosion of natural and manmade (e.g., levees) features. In Germany, burrowing by mitten crabs resulted in accelerated erosion and reduced levee stability. Mitten crab burrows have been measured in San Francisco Bay creeks at nearly 40 burrows per m^2 (Rudnick *et al.* 2000). Limited areas of bank collapse have been observed in association with high densities of burrows (Rudnick *et al.* 2000). Although serious detrimental effects have not yet been seen, it is anticipated that continued burrowing could increase erosion rates, impacting physical and biological processes in San Francisco Bay (Cohen and Carlton 1995).

In Europe, Chinese mitten crabs have also had economic impacts as nuisance by-catch in the fishing industry. Crabs caught in fishing nets can destroy the target catch by eating the abdomens of fish. Serious damage to nets can also occur when large numbers of crabs are caught. Similar issues are impacting San Francisco fisherman who find large numbers of mitten crabs caught in the shrimp trawl nets. Also affecting the fishing industry, mitten crabs have been known to fill eel traps in Europe and crayfish traps in San Francisco, preventing the target catch from entering (Veldhuizen and Stanish 1999).

So far, the most noticeable effect of the Chinese mitten crab in California has been on fish salvage operations. State and Federal facilities divert water from the Sacramento-San Joaquin Delta and use fish salvage operations to transport fish around the diversion. Recently, the appearance of Chinese mitten crabs has seriously hindered fish salvage operations by filling holding tanks and transport trucks. In 1998, nearly 1 million crabs entered the Federal facility, at rates of up to 40,000 crabs per day (Veldhuizen and Stanish 1999). This had serious impacts on the effectiveness of the salvage operations leading to increased mortality of fish.

Health concerns are also associated with the Chinese mitten crab. This species is the secondary host to the Oriental lung fluke. Mammals, including humans, are the primary host of the fluke and may be infected through consumption of mitten crabs. Symptoms of lung fluke infection are similar to tuberculosis or influenza. So far, neither the lung fluke nor any of the snails that serve as the primary intermediate host have been found in San Francisco Bay. However, the high rate of NIS introductions and invasions to this area suggest that it may be a problem in the future.

3 – Brown Mussel in Texas

Figure A-4. Brown Mussels (Courtesy of U.S. Fish and Wildlife Service)

In 1990, a small unidentified mollusk was discovered on the Port Aransas Jetty in Texas. A genetic investigation eventually confirmed this individual as *Perna perna,* the brown mussel (Figure A-4), native to the Atlantic coasts of South America and Africa. The genetic identification also added valuable support to the hypothesis that this species had been imported to U.S. waters via ballast discharge (Holland 1997). The life history traits of these species make it a strong bioinvader. These traits include extensive capacity for dispersal, rapid growth, high productivity, and high tolerances to hypoxia and salinity ranges (Hicks *et al.* 2001).

While this species has clearly become established in the western Gulf of Mexico, its ultimate invasive success is yet to be determined. Its presence in the Gulf of Mexico make it poised for potential introduction into vast areas of the U.S. through the Intracoastal Waterway (Barrett-O'Leary 1999). Currently, only limited biofouling in the Gulf of Mexico has occurred, impacting some mariculture intake pipes and navigation buoys, although the brown mussel has shown severe fouling in other areas including Brazil and India (http://seagrantnews.org/news/txmussels.html, accessed in January 2003).

4 – Veined Rapa Whelk in Chesapeake Bay

Figure A-5. Rapana venosa (Photo credit ©2001. Juliana M. Harding. Department of Fisheries Science, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062.)

The veined rapa whelk (*Rapana venosa*) (Figure A-5) was first observed in the Chesapeake Bay in 1998. It is thought that the introduction of this species to U.S. waters may have been through planktonic larvae in ballast water, or egg masses transported with mariculture products. The establishment of this species in U.S. waters has led to concern for the potential impact on the local shellfish population and related industries. The rapa whelk is a voracious predator feeding on native mollusks, including oysters. The species has high tolerances for salinity, oxygen content, and pollution.

Research is just beginning into the distribution and potential impacts of the rapa whelk in U.S. waters. It is a well known pest species in the Black Sea with widespread ecological impacts on bottom dwelling communities. Locally, the rapa whelk has been shown to feed on barnacles, oyster spat, mussels, and clams (Mann and Harding 2000). In addition to traditional diets, the rapa whelk in the Chesapeake Bay may have developed a trait unique to this area. In sandy bottoms, the whelk will burrow almost completely into the sand expanding the vulnerable prey items to include infaunal shellfish (Harding and Mann 1999). One of the more subtle ecological effects observed is that of increased hermit crab size. Empty *Rapana* shells provide a larger shelter for hermit crabs than typically available. As a result, hermit crabs have reached previously unreported sizes (Harding and Mann 1999). The presence of abnormally large crustacean scavengers may have implications for benthic infauna in the Chesapeake Bay.

Appendix B

US FISH AND WILDLIFE SERVICE

LISTED, PROPOSED, AND CANDIDATE SPECIES AND DESIGNATED OR PROPOSED CRITICAL HABITAT THAT MAY OCCUR IN THE AREA AFFECTED BY THE COAST GUARD'S PROPOSED BALLAST WATER DISCHARGE PROCESS

Common Name	ESA Status	Scientific Name	Critical Habitat
FISH/SHELLFISH			
Alabama Cavefish	Endangered	*Speoplatyrhinus poulsoni*	Designated
Alabama Sturgeon	Endangered	*Scaphirhynchus suttkusi*	
Amber Darter	Endangered	*Percina antesella*	Designated
Arkansas River Shiner	Threatened	*Notropis girardi*	
Atlantic Salmon	Endangered	*Salmo salar*	
Bayou Darter	Threatened	*Etheostoma rubrum*	

Blackside Dace	Threatened	*Etheostoma rubrum*	
Bluemask Darter	Threatened	*Phoxinus cumberlandensis*	
Blue Shiner	Threatened	*Cyprinella caerulea*	
Boulder Darter	Endangered	*Etheostoma wapiti*	
Bull Trout	Threatened	*Salvelinus confluentus*	
Cahaba Shiner	Endangered	*Notropis cahabae*	Designated
Cape Fear Shiner	Endangered	*Notropis mekistocholas*	Designated
Cherokee Darter	Threatened	*Etheostoma scotti*	
Conasauga Logperch	Endangered	*Percina jenkinsi*	Designated
Delta Smelt	Threatened	*Hypomesus transpacificus*	Designated
Duskytail Darter	Endangered	*Etheostoma percnurum*	
Etowah Darter	Endangered	*Etheostoma etowahae*	
Goldline Darter	Threatened	*Percina aurolineata*	
Gulf Sturgeon	Threatened	*Acipenser oxyhynchus desotoi*	Designated (proposed)
Leopard Darter	Threatened	*Percina pantherina*	Designated
Maryland Darter	Endangered	*Etheostoma sellare*	
Okaloosa Darter	Endangered	*Etheostoma okaloosae*	

Ozark Cavefish	Threatened	*Amblyopsis rosae*	
Palezone Shiner	Endangered	*Notropis albizonatus*	
Pallid Sturgeon	Endangered	*Scaphirynchus albus*	
Pygmy Madtom	Threatened	*Cottus paulus*	
Relict Darter	Endangered	*Etheostoma chienense*	
Sacramento Splittail	Threatened	*Pogonichthys macrolepidotus*	
Santa Ana Sucker	Threatened	*Catostomus santaanae*	
Short-nosed Sturgeon	Endangered	*Acipenser brevirostrum*	
Slackwater Darter	Threatened	*Etheostoma boschungi*	Designated
Slender Chub	Threatened	*Erimystax cahni*	Designated
Smoky Madtom	Endangered	*Noturus baileyi*	Designated
Snail Darter	Threatened	*Percina tanasi*	
Spotfin Chub	Threatened	*Cyprinella monacha*	Designated
Tidewater Goby	Endangered	*Eucyclogobius newberryi*	Designated
Topeka Shiner	Endangered	*Notropis topeka*	
Vermillion Darter	Endangered	*Etheostoma chermocki*	
Waccamaw Silverside	Threatened	*Menidia extensa*	Designated

Watercress Darter	Threatened	*Etheostoma nuchale*	Designated
Reptiles and Amphibians			
Alabama Red-bellied Turtle	Endangered	*Pseudemys alabamensis*	
American Crocodile	Endangered	*Crocodylus acutus*	Designated
Atlantic Salt Marsh Snake	Threatened	*Nerodia clarkii taeniata*	
Bog Turtle	Threatened	*Clemmys muhlenbergii*	
California Red-legged Frog	Threatened	*Rana aurora draytonii*	
Copperbelly Water Snake	Threatened	*Nerodia erythrogaster neglecta*	
Eastern Indigo Snake	Threatened	*Drymarchon corais couperi*	
Flattened Musk Turtle	Threatened	*Sternotherus depressus*	
Flatwoods Salamander	Threatened	*Ambystoma cingulatum*	
Giant Garter Snake	Threatened	*Thamnophis gigas*	
Golden Coqui	Threatened	*Eleutherodactylus jasperi*	Designated
Green Sea Turtle	Threatened	*Chelonia mydas*	
Guajon	Threatened	*Eleutherodactylus cooki*	
Hawksbill Sea Turtle	Endangered	*Eretmochelys imbricata*	Designated
Kemp's Ridley Sea Turtle	Endangered	*Lepidochelys kempii*	

Lake Erie Water Snake	Threatened	*Nerodia sipedon insularum*	
Leatherback Sea Turtle	Endangered	*Dermochelys coriacea*	Designated
Loggerhead Sea Turtle	Threatened	*Caretta caretta*	
Olive Ridley Sea Turtle	Threatened	*Lepidochelys olivacea*	
Puerto Rican Crested Toad	Threatened	*Peltophryne lemur*	
Ringed Map Turtle	Threatened	*Graptemys oculifera*	
San Francisco Garter Snake	Endangered	*Thamnophis sirtalis tetrataenia*	
Yellow-blotched Map Turtle	Threatened	*Graptemys flavimaculata*	
Birds			
Attwater' s Greater Prairie-chicken	Endangered	*Tympanuchus cupido attwateri*	
Bald Eagle	Threatened	*Haliaeetus leucocephalus*	
Brown Pelican	Endangered	*Pelecanus occidentalis*	
California Clapper Rail	Endangered	*Rallus longirostris obsoletus*	
California Least Tern	Endangered	*Sterna antillarum browni*	
Eskimo Curlew	Endangered	*Numenius borealis*	
Hawaiian Coot	Endangered	*Fulica americana alai*	
Hawaiian Common Moorhen	Endangered	*Gallinula chioropus sandvicensis*	

Hawaiian Dark-rumped Petrel	Endangered	*Pterodroma phaeopygia sandwichensis*	
Hawaiian Stilt	Endangered	*Himantopus mexicanus knudseni*	
Least Tern	Endangered	*Sterna antillarum*	
Light-footed Clapper Rail	Endangered	*Rallus longirostris levipes*	
Marbled Murrelet	Threatened	*Brachyramphus marmoratus*	
Mississippi Sandhill Crane	Endangered	*Grus canadensis pulla*	Designated
Newell's Shearwater	Threatened	*Puffinus auricularis newelli*	
Piping Plover	Threatened	*Charadrius melodus*	Designated
Puerto Rican Sharp-shinned Hawk	Endangered	*Buteo platypterus brunnescens*	
Roseate Tern	Threatened	*Sterna dougallii dougallii*	
San Clemente Loggerhead Shrike	Endangered	*Lanius ludovicianus mearnsi*	
San Clemente Sage Sparrow	Threatened	*Amphispiza belli clementeae*	
Short-tailed Albatross	Endangered	*Phoebastria albatrus*	
Spectacled Eider	Threatened	*Somateria fischeri*	Designated
Steller's Eider	Threatened	*Polysticta stelleri*	Designated
Western Snowy Plover	Threatened	*Charadrius alexandrinus nivosus*	Designated
Whooping Crane	Endangered	*Grus americana*	Designated

Wood Stork	Endangered	*Mycteria americana*	
Mammals			
Alabama Beach Mouse	Endangered	*Peromyscus polionotus ammobates*	Designated
Gray Bat	Endangered	*Myotis grisescens*	
Indiana Bat	Endangered	*Myotis sodalis*	Designated
Ozark Big-eared Bat	Endangered	*Corynorhinus townsendii ingens*	
Virginia Big-eared Bat	Endangered	*Corynorhinus townsendii virginianus*	Designated
Salt Marsh Harvest Mouse	Endangered	*Reithrodontomys raviventris*	
Southern Sea Otter	Threatened	*Enhydra lutris nereis*	
West Indian Manatee (=Florida)	Endangered	*Trichechus manatus*	Designated
Invertebrates			
Anthony's Riversnail	Endangered	*Athearnia anthonyi*	
Armored Snail	Endangered	*Pyrgulopsis pachyta*	
Behren's Silverspot Butterfly	Endangered	*Speyenia zerene behrensii*	
California Freshwater Shrimp	Endangered	*Syncaris pacifica*	
Cylindrical Lioplax	Endangered	*Lioplax cyclostomaformis*	
Flat Pebblesnail	Endangered	*Lepyrium showalteri*	

Lacy Elimia	Threatened	*Elimia crenatella*	
Magazine Mountain Shagreen	Threatened	*Mesodon magazinensis*	
Morro Shoulderband (=banded dune) Snail	Endangered	*Helminthoglypta walkeriana*	
Myrtle's Silverspot Butterfly	Endangered	*Speyeria zerene myrtleae*	
Noonday Snail	Threatened	*Mesodon clarki nantahala*	
Oregon Silverspot Butterfly	Threatened	*Speyeria zerene hippolyta*	
Painted Rocksnail	Threatened	*Leptoxis* taeniata	
Plicate Rocksnail	Endangered	*Leptoxis plicata*	
Round Rocksnail	Threatened	*Leptoxis ampla*	
Royal Marstonia Snail	Endangered	*Pyrgulopsis ogmoraphe*	
Shasta Crayfish	Endangered	*Pacifastacus fortis*	
Slender Campeloma	Endangered	*Campeloma decampi*	
Tulotoma Snail	Endangered	*Tulotoma magnifica*	
Mussels			
Alabama Lampmussel	Endangered	*Lampsilis virescens*	
Alabama Moccasinshell	Threatened	*Medionidus acutissimus*	
Appalachian Elktoe	Endangered	*Alasmidonta raveneliana*	

Appalachian Monkeyface Pearlymussel	Endangered	*Quadrula sparsa*	Designated (proposed)
Black Clubshell	Endangered	*Pleurobema curtum*	
Carolina Heelsplitter	Endangered	*Lasmigona decorata*	
Chipola Slabshell	Threatened	*Elliptio chipolaensis*	
Coosa Moccasinshell	Endangered	*Medionidus parvulus*	
Cracking Pearlymussel	Endangered	*Hemistena lata*	
Cumberland Bean Pearlymussel	Endangered	*Villosa trabalis*	
Cumberland Elktoe	Endangered	*Alasmidonta atropurpurea*	
Cumberland Monkeyface Pearlymussel	Endangered	*Cumberland intermedia*	
Cumberlandian Combshell	Endangered	*Epioblasma brevidens*	
Curtis' Pearlymussel	Endangered	*Epioblasma florentina curtisi*	
Dark Pigtoe	Endangered	*Pleurobema furvum*	
Dromedary Pearlymussel	Endangered	*Dromus dromas*	
Dwarf Wedge Mussel	Endangered	*Alasmidonta heterodon*	
Fanshell Mussel	Endangered	*Cyprogenia stegaria*	
Fat Pocketbook Pearlymussel	Endangered	*Potamilis capax*	
Fat Threeridge	Endangered	*Amblema neislerii*	

Fine-lined Pocketbook	Threatened	*Lampsilis altilis*	
Fine-rayed Pigtoe	Endangered	*Fusconaia cuneolus*	
Green-blossom Pearlymussel	Endangered	*Epioblasma torulosa gubernaculum*	
Gulf Moccasinshell	Endangered	*Medionidus penicillatus*	
Heavy Pigtoe	Endangered	*Pleurobema taitianum*	
Higgins' Eye Pearlymussel	Endangered	*Lampsilis higginsi*	
Alabama (Inflated) Heelsplitter	Threatened	*Potamilus inflatus*	
Little-wing Pearlymussel	Endangered	*Pegias fabula*	
Louisiana Pearlshell	Threatened	*Margaritzjfera hembeli*	
Flat Pigtoe Mussel	Endangered	*Pleurobema marshalli*	
Northern Riffleshell	Endangered	*Epioblasma torulosa ran giana*	
Ochlockonee moccasinshell	Endangered	*Medionidus simpsonianus*	
Orange footed Pearlymussel	Endangered	*Plethobasis cooperianus*	
Orange-nacre Mucket	Threatened	*Lampsilis perovalis*	
Ouachita Rock-pocketbook	Endangered	*Arkansia wheeleri*	
Oval Pigtoe	Endangered	*Pleurobema pyiforme*	
Ovate Clubshell	Endangered	*Pleurobema perovatum*	

Oyster Mussel	Endangered	*Epioblasma capsaeformis*	
Pale Lilliput Pearlymussel	Endangered	*Toxolasma cylindrellus*	
Pink Mucket Pearlymussel	Endangered	*Lampsilis orbiculata*	
Purple Bankclimber	Threatened	*Elliptoideus sloatianus*	
Purple Bean	Endangered	*Villosa perpurpurea*	
Purple Cat's Paw Pearlymussel	Endangered	*Epioblasma obliquata obliquata*	
Ring Pink Mussel	Endangered	*Obovaria retusa*	
Rough Pigtoe	Endangered	*Pleurobema plenum*	
Rough Rabbitsfoot	Endangered	*Quadrula cylindrica strigillata*	
Scaleshell	Endangered	*Leptodea leptodon*	
Shiny Pigtoe	Endangered	*Fusconaia cor*	
Shinyrayed Pocketbook	Endangered	*Lampsilis subangulata*	
Southern Acornshell	Endangered	*Epioblasma othcaloogensis*	
Southern Clubshell	Endangered	*Pleurobema decisum*	
Southern Pigtoe	Endangered	*Pleurobema georgianum*	
Speckled Pocketbook	Endangered	*Lampsilis streckeri*	
Stirrup Shell	Endangered	*Quadrula stapes*	

Tan Riffle Shell	Endangered	*Epiolasma florentina walkeri*	
Tar (River) Spinymussel	Endangered	*Elliptio steinstansana*	
Triangular Kidneyshell	Endangered	*Ptychobranchus greeni*	
Tubercled-blossom Pearlymussel	Endangered	*Epioblasma torulosa torulosa*	
Turgid-blossom Pearlymussel	Endangered	*Epioblasma turgidula*	
Upland Combshell	Endangered	*Epioblasma metastriata*	
White Wartyback Pearlymussel	Endangered	*Plethobasus cicatricosus*	
White Cat's Paw Pearlymussel	Endangered	*Epioblasma obliquata perobliqua*	
Winged Mapleleaf Mussel	Endangered	*Quadrula fragosa*	
Yellow-blossom Pearlymussel	Endangered	*Epioblasma florentina florentina*	
Insects			
Hine's Emerald Dragonfly	Endangered	*Somatochlora hineana*	
Hungerford's Crawling Water Beetle	Endangered	*Brychius hungerfordi*	
Northeastern Beach Tiger Beetle	Threatened	*Cicindela dorsalis dorsalis*	
Puritan Tiger Beetle	Threatened	*Cicindela puritana*	
Plants			
Beach Layia	Endangered	*Layia carnosa*	

Clover Lupine [Tidestrom's lupine]	Endangered	*Lupinus tidestromii*	
California Sea Blite	Endangered	*Suaeda californica*	
Coastal Dunes Milk-vetch	Endangered	*Astragalus tener var. titi*	
Contra Costa Goldfields	Endangered	*Lasthenia conjugens*	
Howell's Spineflower	Endangered	Chorizanthe howe/lu	
Island Rush-rose	Threatened	*Helianthemum greenei*	
La Graciosa Thistle	Endangered	*Cirsium loncholepis*	
Laguna Beach Live-forever	Threatened	*Dudleya stolonifera*	
Lyon's Pentachaeta	Endangered	*Pentachaeta lyonii*	
Marsh Sandwort	Endangered	*Arenaria paludicola*	
Menzies's Wallflower	Endangered	*Erysimum menziesii*	
Prairie Dawn	Endangered	*Hymenoxys texana*	
Robust Spineflower	Endangered	*Chorizanthe robusta var. robusta*	
Salt Marsh Bird's Beak	Endangered	*Cordylanthus maritimus ssp. maritimus*	
Santa Cruz Island Rock-cress	Endangered	*Sibara filifola*	
Sea Beach Amaranth	Threatened	*Amaranthus pumilus*	
Sensitive Joint-vetch	Threatened	*Aeschynomene virginica*	

Soft Bird's Beak	Endangered	*Cordylanthus mollis ssp. mollis*	
Sonoma Spineflower	Endangered	*Chorizanthe valida*	
Suisun Thistle	Endangered	*Cirsium hydrophilum var. hydrophilum*	
Ventura Marsh Milk-vetch	Endangered	*Astragalus pycnostachyus var. lanosissimus*	
Water Howellia	Threatened	*Howellia aquatilis*	

PROPOSED SPECIES

<u>Fish</u>
Coastal Cutthroat Trout *(Onchorhynchus clarki clarki),* T proposed

CANDIDATE SPECIES

<u>Birds</u>
Streaked Horned Lark *(Eremophila alpestris strigata*)

Appendix B (con't)

National Marine Fisheries Service

Listed and Proposed Species

Common Name	Population Name	ESA Status	Scientific Name	Critical Habitat
FISH/SHELLFISH				
Salmon, Atlantic	Gulf of Maine DPS	Endangered	*Salmo salar*	NA
Salmon, chinook	Upper Willamette River	Threatened	*Oncorhynchus tshawytscha*	NA
Salmon, chinook	Lower Columbia River	Threatened	*Oncorhynchus tshawytscha*	NA
Salmon, chinook	Puget Sound	Threatened	*Oncorhynchus tshawytscha*	NA
Salmon, chinook	Central Valley spring-run	Threatened	*Oncorhynchus tshawytscha*	NA
Salmon, chinook	Snake River fall-run	Threatened	*Oncorhynchus tshawytscha*	Designated
Salmon, chinook	California Coastal	Threatened	*Oncorhynchus tshawytscha*	NA
Salmon, chinook	Snake River spring/summer-run	Threatened	*Oncorhynchus tshawytscha*	Designated
Salmon, chinook	Sacramento River winter-run	Endangered	*Oncorhynchus tshawytscha*	Designated
Salmon, chinook	Upper Columbia River spring-run	Endangered	*Oncorhynchus tshawytscha*	NA
Salmon, chum	Columbia River	Threatened	*Oncorhynchus keta*	NA
Salmon, chum	Hood Canal summer-run	Threatened	*Oncorhynchus keta*	NA
Salmon, coho	Oregon Coast	Threatened	*Oncorhynchus kisutch*	NA

Salmon, coho	Central California Coast	Threatened	*Oncorhynchus kisutch*	Designated
Salmon, coho	Southern Oregon/Northern California Coast	Threatened	*Oncorhynchus kisutch*	Designated
Salmon, sockeye	Ozette Lake	Threatened	*Oncorhynchus nerka*	NA
Salmon, sockeye	Snake River	Endangered	*Oncorhynchus nerka*	Designated
Sawfish, smalltooth	USDPS	Endangered	*Pristis pectinata*	NA
Steelhead	Middle Columbia River	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	California Central Valley	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	Upper Willamette River	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	Northern California	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	Lower Columbia River	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	Snake River Basin	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	South-Central California Coast	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	Central California Coast	Threatened	*Oncorhynchus mykiss*	NA
Steelhead	Upper Columbia River	Endangered	*Oncorhynchus mykiss*	NA
Steelhead	Southern California	Endangered	*Oncorhynchus mykiss*	NA
Sturgeon, Gulf	Range-wide	Threatened	*Acipenser oxyrinchus desotoi*	Designated
Sturgeon, shortnose	Range-wide	Endangered	*Acipenser brevirostrum*	NA

Abalone, white	California	Endangered	*Haliotis sorenseni*	NA
PLANTS				
Seagrass, Johnson's	Range-wide	Threatened	*Halophila]ohnsonii*	Designated
MARINE MAMMALS / SEA TURTLES				
Sea Lion, Steller	East of 144^0 Long (Eastern US)	Threatened	*Eumetopias jubatus*	Designated
Sea Lion, Steller	West of 144^0 Long (Western US)	Endangered	*Eumetopias jubatus*	Designated
Seal Caribbean monk	Range-wide	Endangered	*Monachus tropicalis*	NA
Seal, Hawaiian monk	Hawaiian Islands	Endangered	*Monachus schauinslandi*	Designated
Whale, blue	Range-wide	Endangered	*Balaenoptera musculus*	NA
Whale, bowhead	Range-wide	Endangered	*Balaena mysticetus*	NA
Whale, fin	Range-wide	Endangered	*Balaenoptera physalus*	NA
Whale, humpback	Range-wide	Endangered	*Megaptera novaeangliae*	NA
Whale, right	Range-wide	Endangered	*Eubalaena glacialis*	Designated
Whale, sei	Range-wide	Endangered	*Balaenoptera borealis*	NA
Whale, sperm	Range-wide	Endangered	*Physeter macrocephalus (catodon)*	NA
Turtle, green sea	Range-wide	Threatened	*Chelonia mydas*	Designated
Turtle, green sea	Mexican Breeding Population	Endangered	*Chelonia mydas*	NA

Turtle, green sea	Florida Breeding Populations	Endangered	*Chelonia mydas*	NA
Turtle, hawksbill sea	Range-wide	Endangered	*Eretmochelys imbricata*	Designated
Turtle, Kemp's ridley sea	Range-wide	Endangered	*Lepidochelys kempii*	NA
Turtle, leatherback sea	Range-wide	Endangered	*Dermochelys coriacea*	Designated
Turtle, loggerhead sea	Range-wide	Threatened	*Carette caretta*	NA
Turtle, olive ridley	Range-wide	Threatened	*Lepidochelys olivacea*	NA
Turtle, olive ridley	Mexican Breeding Population	Endangered	*Lepidochelys olivacea*	NA

APPENDIX C

FEDERALLY APPROVED

COASTAL ZONE MANAGEMENT PROGRAMS

STATE
Alabama
Alaska
American Samoa
California
Connecticut
Delaware
Florida
Georgia
Guam
Hawaii
Indiana
Illinois*
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
New Hampshire
New Jersey
New York
North Carolina
Northern Mariana Islands
Ohio
Oregon
Pennsylvania
Puerto Rico
Rhode Island
South Carolina
Texas
US Virgin Islands
Virginia
Washington
Wisconsin

*Inactive